FM-10A 10 KILOWATT FM BROADCAST TRANSMITTER

597-0098
JUNE, 1986

SCOPE OF MANUAL

This manual consists of two sections which provides the following information for the Broadcast Electronics FM-10A transmitter.

A. PART I - Contains information relative to installation, operation, and maintenance applicable to the overall transmitter.

B. PART II - Contains detailed information for the following transmitter modular units.

1. IPA
2. AUTOMATIC POWER CONTROL
3. TRANSMITTER CONTROLLER

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. Information presented by this section provides a general description of the Broadcast Electronics FM-10A transmitter and lists equipment specifications.

1-3. RELATED PUBLICATIONS.

1-4. The following list of publications provides data for equipment associated with the FM-10A transmitter.

PUBLICATION NUMBER	EQUIPMENT
597-0002	FX-30 FM EXCITER
597-0008	FC-30 SCA GENERATOR
597-0009	FS-30 STEREO GENERATOR
597-0036	MICROPROCESSOR VIDEO DIAGNOSTIC SYSTEM (MVDS)

1-5. EQUIPMENT DESCRIPTION.

1-6. The Broadcast Electronics FM-10A is a one-tube 10 kW FM transmitter designed for continuous operation in the 87.5 MHz to 108 MHz FM broadcast band (refer to Figure 1-1). Specific transmitter features include: a folded half-wave cavity PA stage, a solid-state control system with a microprocessor based video diagnostic option, a solid-state intermediate power amplifier (IPA), a solid-state automatic power control (APC) unit, and a solid-state exciter with a digital frequency synthesizer. The RF power amplifier, IPA, FM exciter, and control circuitry is housed in a single cabinet. A high voltage power supply is housed in a separate cabinet which may be located remotely from the PA/driver cabinet if desired. The following text provides ordering information for various transmitter configurations, optional equipment, and accessories and recommended spare parts kits.

1-7. TRANSMITTER CONFIGURATIONS.

1-8. The FM-10A may be ordered in the following configurations:

PART NUMBER	DESCRIPTION
909-1110-200	FM-10A Transmitter complete with FX-30 FM Exciter, 208/240V ac three-phase 60 Hz operation, high voltage power supply adjacent to PA/driver cabinet.
909-1110-210	Same as 909-1110-200 less exciter.

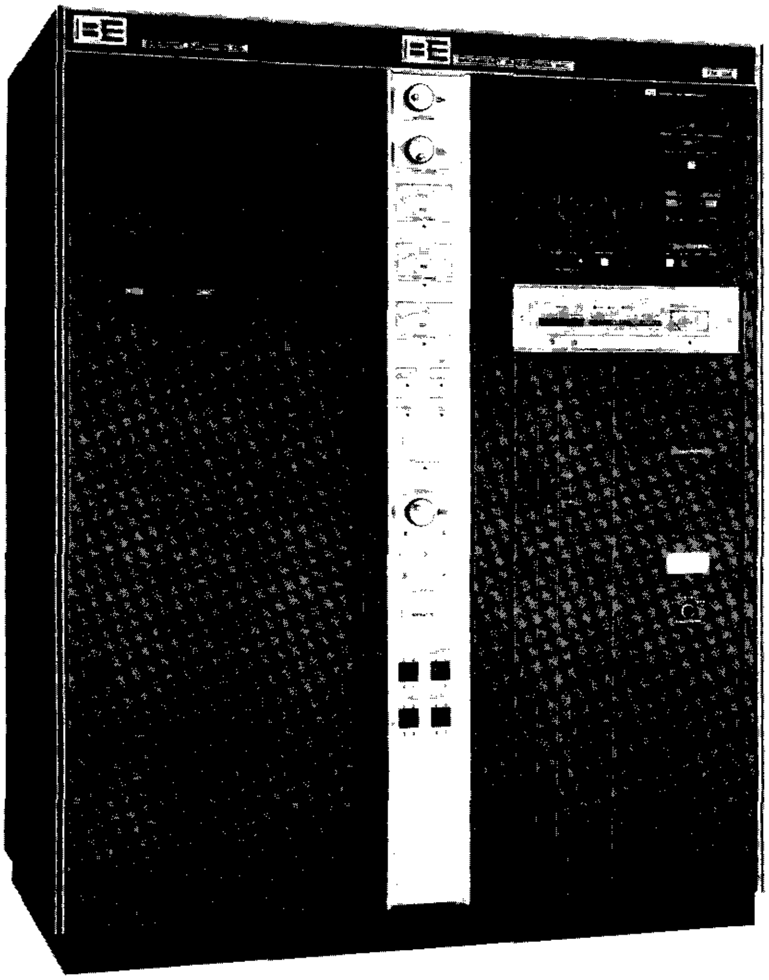

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FIGURE 1-1. FM-10A TRANSMITTER

909-1110-201	FM-10A Transmitter complete with FX-30 FM Exciter, 208/240V ac three-phase 60 Hz operation, remote high voltage power supply.
909-1110-211	Same as 909-1110-201 less exciter.
909-1110-380	FM-10A Transmitter complete with FX-30 FM Exciter, 208/380V ac three-phase 50 Hz operation, high voltage power supply adjacent to PA/driver cabinet.
909-1110-381	FM-10A Transmitter complete with FX-30 FM Exciter, 208/380V ac three-phase 50 Hz operation, remote high voltage power supply.

1-9. OPTIONAL EQUIPMENT.

1-10. The FM-10A transmitter is available with the following options:

PART NUMBER	DESCRIPTION
909-0115	1.5 kW filament voltage regulator, 60 Hz operation, factory installed.
909-0116	1.5 kW filament voltage regulator, 50 Hz operation, factory installed.
909-0098	Three-phase ac voltage meter, factory installed.
909-0091-005	Microprocessor Video Diagnostic System, factory installed.
979-0091-060	Microprocessor Video Diagnostic System, field installation kit.

1-11. ACCESSORIES AND SPARE PARTS KITS.

1-12. The following accessory products and spare parts kits are available for use in the FM-10A transmitter:

PART NUMBER	DESCRITPION
909-0103	Extended local control unit.
909-0050	FS-30 FM stereo generator.
909-0051	FC-30 FM SCA generator.
240-0001	Spare tube, 4CX7500A.
979-0044	Recommended spare parts kit for the FM-10A (less exciter spares). Includes selected meters, switches, relays etc. Does not include semiconductors.
979-0045	Recommended spare semiconductor kit for the FM-10A (includes exciter spares).
979-0055	100% semiconductor kit for the FM-10A (includes exciter spares).

1-13. EQUIPMENT SPECIFICATIONS.

1-14. Refer to Table 1-1 for the electrical specifications and Table 1-2 for the physical and environmental specifications of the Broadcast Electronics FM-10A transmitter.

TABLE 1-1. FM-10A ELECTRICAL SPECIFICATIONS
(Sheet 1 of 2)

PARAMETER	SPECIFICATION
RF POWER OUTPUT	4.5 kW to 11.0 kW (as specified).
FREQUENCY RANGE	87.5 to 108 MHz (as specified). Exciter programmable in 10 kHz increments.
RF OUTPUT IMPEDANCE	50 Ohms, resistive (others available by special request).
RF OUTPUT CONNECTOR	3 1/8 inch EIA flange. 1 5/8 inch EIA flange available by special request.
MAXIMUM VSWR	1.8:1 (will operate into a higher VSWR with automatic power reduction).
TUBE COMPLEMENT	4CX7500A
AM SIGNAL-TO-NOISE RATIO:	
Asynchronous	55 dB below a reference carrier with 100% AM modulation @ 400 Hz, 75 microsecond deemphasis (no FM modulation present).
Synchronous	45 dB below a reference carrier with 100% AM modulation @ 400 Hz, 75 microsecond deemphasis (FM modulation: ±75 kHz @ 400 Hz).
FM SIGNAL-TO-NOISE RATIO:	
Mono	72 dB below ±75 kHz deviation @ 400 Hz (75 dB typical) measured in a 30 Hz to 15 kHz bandwidth with 75 microsecond deemphasis.
Stereo	72 dB or better below 100% modulation @ 400 Hz, 75 microsecond deemphasis.
DISTORTION	
Harmonic	0.08% or less (0.04% typical).
Intermodulation Distortion	0.08% or less, 60 Hz/7 kHz, 4:1 Ratio.

TABLE 1-1. FM-10A ELECTRICAL SPECIFICATIONS
(Sheet 2 of 2)

PARAMETER	SPECIFICATION
Transient Intermodulation Distortion	0.1% or less (square wave/sine wave).
RF HARMONIC SUPPRESSION	Meets all FCC/DOC requirements and CCIR recommendations.
AC POWER REQUIREMENTS	197 to 251V ac 50/60 Hz or 341V to 435V ac 50 Hz, three-phase closed-Delta or Wye (as specified).
AC POWER CONSUMPTION	15.8 kW typical at a 10 kW RF power output, 0.94 power factor.
OVERALL EFFICIENCY	63% typical (AC line input to RF output).

TABLE 1-2. FM-10A PHYSICAL AND ENVIRONMENTAL SPECIFICAITONS
(Sheet 1 of 2)

PARAMETER	SPECIFICATION
PHYSICAL	
DIMENSIONS:	
PA/Driver Cabinet	Width: 33.7 inches (85.6 cm). Height: 69.8 inches (177.29 cm). Depth: 37.2 inches (94.49 cm).
High Voltage Power Supply Cabinet	Width: 22.7 inches (57.66 cm). Height: 69.8 inches (177.29 cm). Depth: 37.2 inches (94.49 cm).
WEIGHT:	
PA/Driver Cabinet	800 pounds (363 kg).
High Voltage Power Supply Cabinet	1000 pounds (453.6 kg).

TABLE 1-2. FM-10A PHYSICAL AND ENVIRONMENTAL SPECIFICAITONS
(Sheet 2 of 2)

PARAMETER	SPECIFICATION
CUBAGE:	
PA/Driver Cabinet	53 cubic feet (1.5 m^3).
High Voltage Power Supply Cabinet	36 cubic feet (1.01 m^3).
LOW-PASS FILTER DIMENSIONS:	
Length	78.9 inches (200.3 cm).
Diameter	3.125 inches
ENVIRONMENTAL	
HEAT DISSIPATION (10 kw OUTPUT)	7 kw (25,000 Btu/H).
COOLING AIR REQUIREMENTS	800 cubic feet per minute (22.6 m^3/min).
AMBIENT TEMPERATURE RANGE	+14°F to +122°F (-10°C to +50°C).
MAXIMUM ALTITUDE	
50 Hz Models	Ø to 7,500 feet above sea level (Ø to 2286 meters).
60 Hz Models	Ø to 10,000 feet above sea level (Ø to 3048 meters).
MAXIMUM HUMIDITY	95%, non-condensing.

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information required for the installation and preliminary checkout of the Broadcast Electronics FM-10A FM Transmitter.

2-3. UNPACKING.

2-4. The equipment becomes the property of the customer when the equipment is delivered to the carrier. Carefully unpack the transmitter. Perform a visual inspection to determine that no apparent damage has been incurred during shipment. All shipping materials should be reretained until it is determined that the unit has not been damaged. Claims for damaged equipment must be promptly filed with the carrier or the carrier may not accept the claim.

2-5. The contents of the shipment should be as indicated on the packing list (see Table 2-1). If the contents are incomplete, or if the unit is damaged electrically or mechanically, notify both the carrier and Broadcast Electronics, Inc.

2-6. INSTALLATION REQUIREMENTS.

2-7. ENVIRONMENTAL.

2-8. Table 1-2 provides environmental conditions which must be considered prior to transmitter installation.

2-9. COOLING AIR.

2-10. If outside air is to be used to cool the transmitter, the air inlet duct must be sized to allow adequate air flow. The air must be dry and well filtered. If intake louvers are used, operation of the louvers must be electrically interlocked with the transmitter operation.

2-11. If the heated transmitter air is to be ducted from the room, the duct system must not introduce any back-pressure on the equipment. Proper allowances for air flow will ensure that only a limited amount of heat is dissipated into the equipment interior. The duct system must allow for a minimum air flow of 800 cubic feet of air per minute (22.6 m^3/min).

2-12. As a minimum requirement, any duct work must have a cross-sectional area equal to the exhaust area of the PA/driver cabinet (refer to Figure 2-1). Sharp bends in the duct system will introduce back-pressure and are not permissible. A radius bend must be used if a right angle turn is required. An exhaust fan may be used to overcome duct losses or overcome wind pressures if the duct is vented to the outside.

TABLE 2-1. FM-10A PACKING LIST

ITEM	DESCRIPTION	BE PART NO.	QTY.
1	PA/Driver Cabinet, Assembled	959-0234	1
2	Power Supply Cabinet, Assembled	959-0233	1
3	PA Tube, 4CX7500A	240-0001	1
4	Transmission Line, Inner, 30.47 inches	427-0008-008	1
5	Transmission Line, Outer, 31.35 inches	427-0008-006	1
6	Transmission Line, Inner, 8.22 inches	427-0008-011	1
7	Transmission Line, Outer, 9.1 inches	427-0008-010	1
8	Transmission Line Coupling, 3 1/8 inch to 1 5/8 inch	427-0051	1
9	Transmission Line Elbow with Center Conductor	427-0006	1
10	Transmission Line Coupling, Unflanged	427-0007	1
11	Flange, 1 5/8 inch	427-0010	1
12	Insulator Connector, 1 5/8 inch	427-0009	1
13	Harmonic Low-Pass Filter, 10 kW	339-0017	1
14	Output Directional Coupler Assembly	959-0082-001	1
15	Manual, FM-10A FM Transmitter	597-0098	1
16	Manual, FX-30 FM Exciter (Not included when shipped less exciter)	597-0002-001	1
17	Cabinet Door Keys	NPN	4
18	Exciter Accessory Kit - Less Rails and Coaxial Cables (Not included when shipped less exciter)	961-0001	1
19	Test Data Sheets, Set	592-0033	1
20	Battery, 9 Volt (Controller)	350-0002	1
21	Hex Key, 5/32 Inch (Lower Front Panel Screws)	710-0219	1
22	Spade Lugs (for Remote Control Terminal Strip)	410-1489	40
23	Header, Programmable, 8-Pin DIP	340-0006	5
24	Extender Circuit Board Assembly	919-0061	1
25	Line Cord, FX-30	682-0001	1

2-13. PRIMARY POWER.

2-14. The FM-10A transmitter is designed for operation from a closed-delta or wye connected three-phase power source. Operation from an unsatisfactory power source will void the warranty on this transmitter as any resultant damage is beyond the control of the manufacturer. Before attempting installation of the transmitter, assure that the proper power source is installed. Acceptable power input configurations are shown in Figure 2-2.

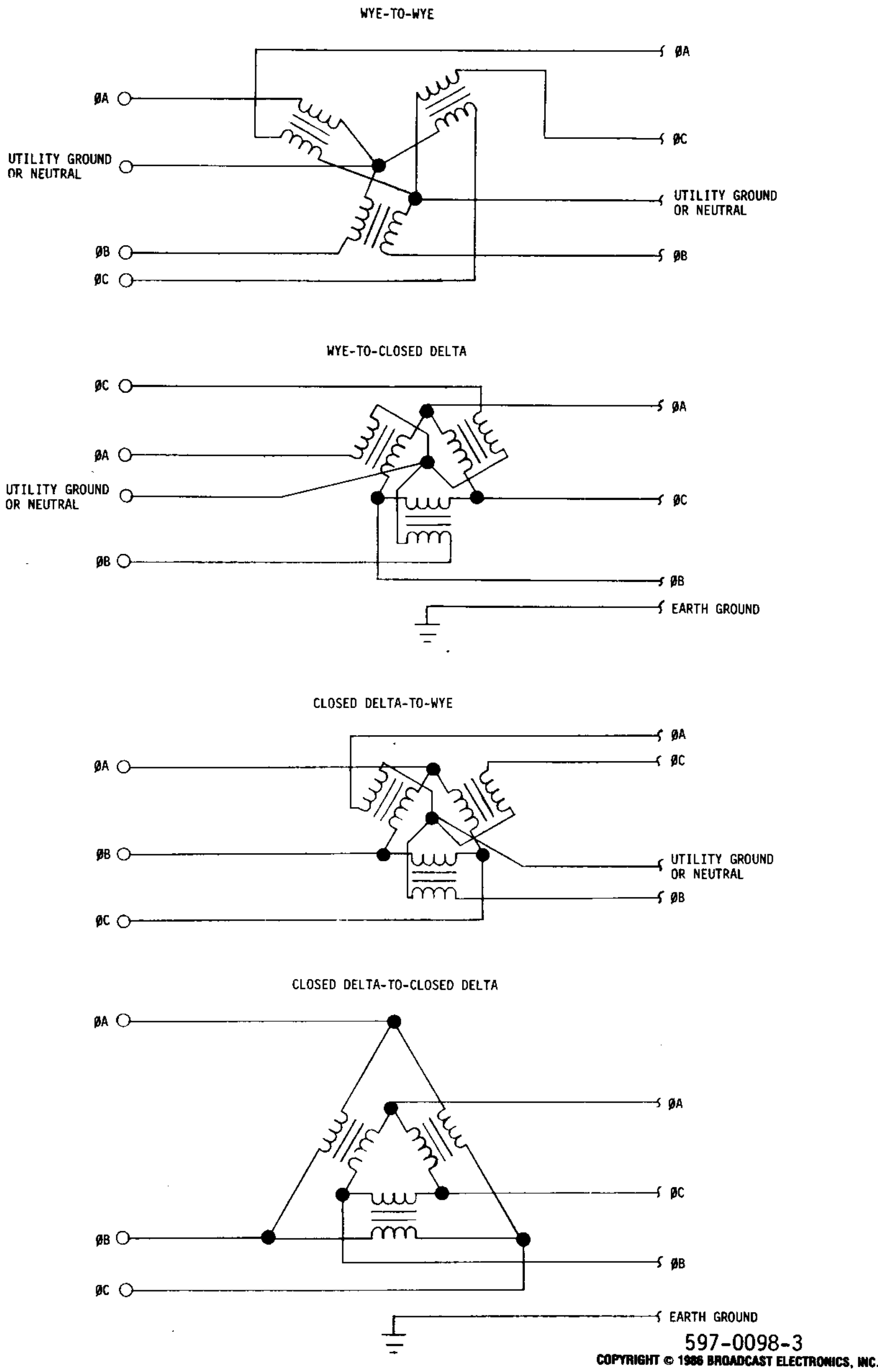

FIGURE 2-2. ACCEPTABLE AC POWER INPUT CONFIGURATIONS

2-16. An open-delta, V to V, T to T, T to L, or Scott connected power source will provide unsatisfactory transmitter performance as transients and unstable power can damage components of the FM-10A and provide degraded transmitter specifications. Any of these systems will develop a considerable imbalance between phases in voltage, phase angle, or both voltage and phase angle. These problems can result in premature failure of power supply and RF circuit components.

2-17. It is important that the local electric utility be consulted to ensure that the correct service is provided before connection of the transmitter to a primary power source. The proper power source can readily be identified by the use of three transformers with one winding each or one transformer with three windings instead of the use of two transformers as required for the unacceptable configurations.

2-18. INSTALLATION.

2-19. Each transmitter is wired, operated, tested, and inspected at the factory prior to shipment and is ready for installation when received. Prior to installation, this publication should be studied to obtain an understanding of the circuitry, nomenclature, and installation requirements. Installation is accomplished as follows: 1) placement, 2) component installation, 3) remote control connections, 4) wiring, and 5) initial checkout.

2-20. EQUIPMENT PLACEMENT.

WARNING ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.

2-21. The FM-10A transmitter is designed for two types of installations: 1) adjacent high voltage power supply cabinet installation or 2) remote high voltage power supply cabinet installation. If the cabinets are positioned apart, access holes in the top and bottom of the cabinets allow either overhead or under-floor routing of interconnecting wiring (see Figure 2-1).

2-22. Regardless of the type of installation, the floor must be capable of supporting the total transmitter weight. The floor support should be more than marginal to maintain proper cabinet alignment and reduce vibration.

2-23. After determining the position of the cabinets, place the PA/driver cabinet in the desired location on a smooth and level surface. Remove the four shipping skid bolts (located under the bottom of the skid) and lift the PA/driver cabinet from the skid.

2-24. Place the power supply cabinet in the desired location and remove the shipping skid (remove four bolts located under the bottom of the skid). If the high voltage power supply is positioned adjacent to the the PA/driver cabinet, the cabinets must be bolted together through the vertical and horizontal chassis rails. Refer to Figure 2-1 and bolt the cabinets together using four 1/4-20 X 1 inch bolts and lock washers (located in the accessory kit).

2-25. COMPONENT INSTALLATION.

<u>WARNING</u> ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.

2-26. For ease of component installation and cabinet wiring, the power supply cabinet rear door, the PA/driver cabinet rear door, and the PA/driver cabinet lower front access panel should be removed and remain off until installation is complete. The power supply and PA/driver cabinet doors may be removed by lifting each door off the hinges. To remove the PA/driver cabinet front panel, remove the four hex-head cap mounting screws with the 5/32 inch hex wrench (located in the accessory kit).

2-27. Interconnecting wires and cables are tied for shipment. Remove all tape, wire ties, string, and packing material. Cables, connectors, and miscellaneous components to be installed are shipped in separate containers. The following text provides information for the installation of these items. Throughout the installation procedures, ensure the transmitter adjustments are not moved from the factory preset positions.

<u>WARNING</u> ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.

2-28. HIGH VOLTAGE POWER SUPPLY CABINET. Unpack components located in the high voltage power supply cabinet as follows.

2-29. Unwrap the grounding stick and place the stick on the interlocked hanger. Ensure the wire tie securing the grounding stick hanger interlock switch is removed.

2-30. Unwrap the cabinet interlock connector. For transmitters with a remote high voltage power supply, unwrap the high voltage cabinet interlock cable.

2-31. Unwrap the PA/driver cabinet ac power cable harness (cable connected to TB16) which is coiled inside the high voltage cabinet.

2-32. The high voltage power supply is equipped with a half-voltage receptacle. Ensure the half-voltage supply jack is inserted into the 6600 VDC receptacle.

<u>WARNING</u> ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.

2-33. PA/DRIVER CABINET. Unpack, check, and install components located in the PA/driver cabinet as follows.

2-34. Controller Cabinet. Due to various shipping methods, the transmitter controller circuit board and the controller extender circuit board may be removed from the controller cabinet. Locate the controller circuit board and install the nine-volt battery (located in the accessory kit) in the transmitter controller battery holder.

2-35. Refer to Figure 2-3 and ensure all controller circuit board jumpers are correctly positioned.

2-36. If the controller circuit board and the extender circuit board are removed for shipment, insert the controller circuit board in the controller cabinet extreme right receptacle with the component side to the left. Insert the extender circuit board in the extreme left receptacle.

2-37. If the transmitter is equipped with the microprocessor video diagnostic system (MVDS), install the MVDS circuit boards and the video monitor by performing the procedure described in SECTION II, INSTALLATION of manual 597-0036.

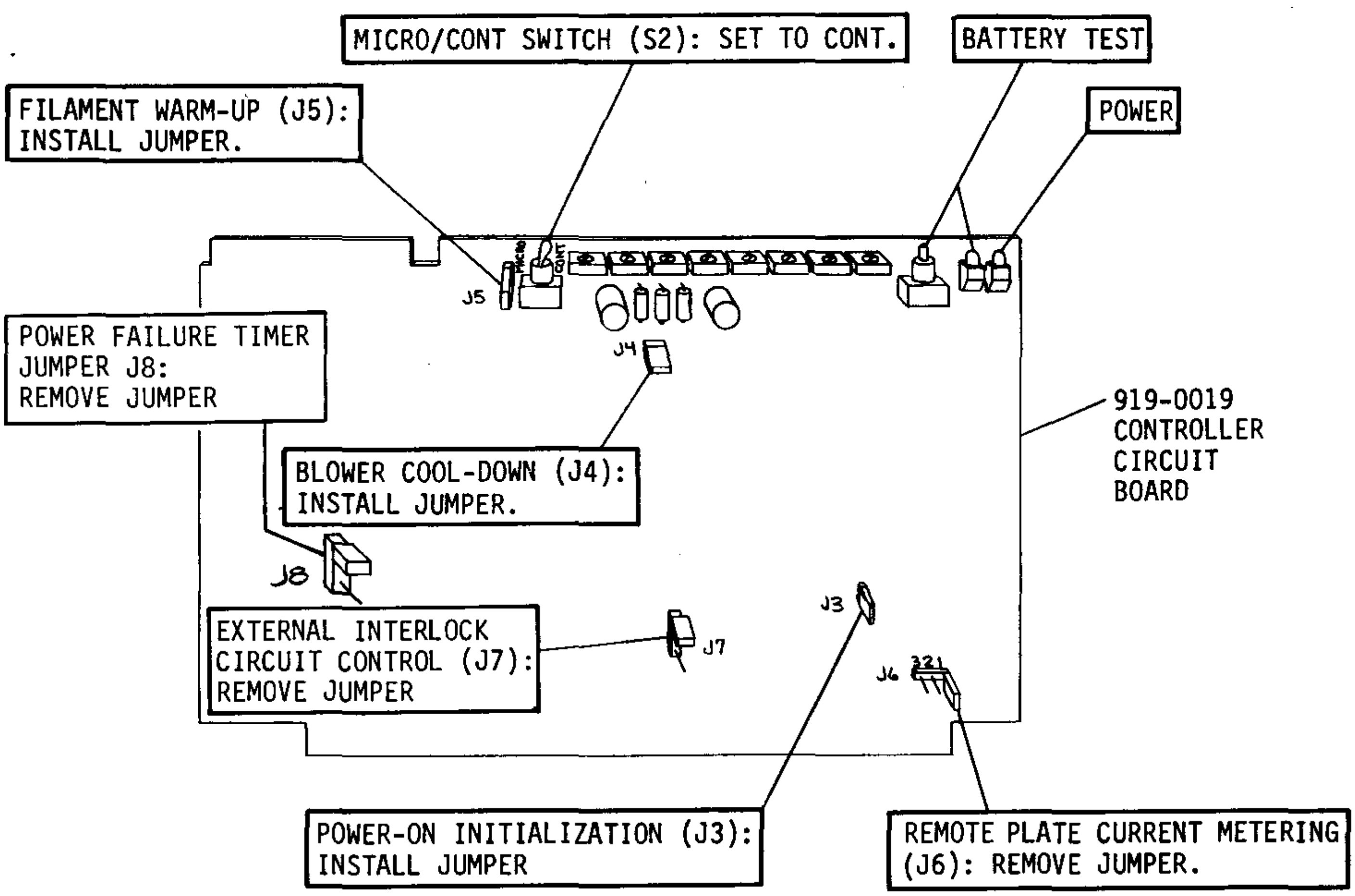

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FIGURE 2-3. CONTROLLER CIRCUIT BOARD JUMPER PROGRAMMING

2-38. Automatic Power Control (APC) Unit. Remove the slide retainers from the APC unit.

2-39. Extend the APC unit forward and remove the top-panel. A flat-blade screwdriver with a 1/4 inch (0.64 cm) tip is required.

NOTE DO NOT REMOVE THE APC UNIT BATTERY. THE BATTERY MAINTAINS THE VALUE STORED IN THE APC POWER LEVEL REFERENCE MEMORY AND MUST REMAIN CONNECTED. NOTE

2-40. Refer to Figure 2-4 and ensure all APC unit jumpers are correctly positioned.

2-41. Replace the APC unit top-panel and secure the unit in the cabinet.

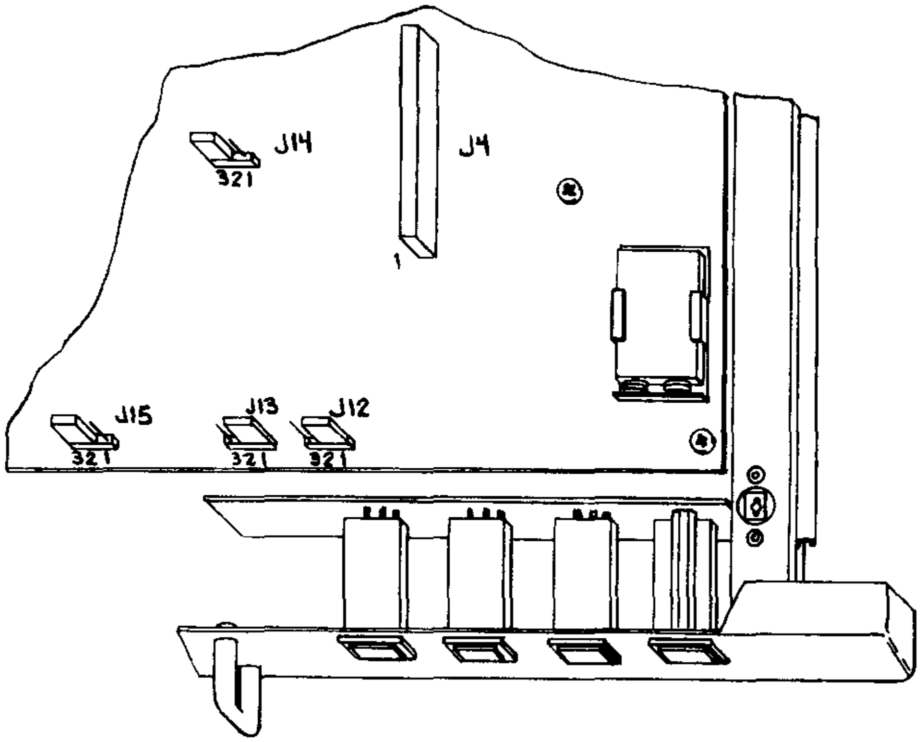

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FIGURE 2-4. APC UNIT CIRCUIT BOARD JUMPER PROGRAMMING

2-42. Ensure the following cables are attached to the APC unit:

CABLE NUMBER	APC UNIT CONNECTOR
625	J9 FWD PWR RF SAMPLE
626	J10 RFL PWR RF SAMPLE

2-43. FX-30 Exciter. Remove the slide retainers from the FX-30 exciter.

2-44. Loosen the exciter front-panel turn-lock fasteners and extend the unit forward.

2-45. Loosen the eight turn-lock fasteners and remove the exciter top-panel.

2-46. Remove any packing material from the inside of the exciter.

2-47. Ensure the TEST/NORMAL switch on the metering assembly is operated to NORMAL.

2-48. Ensure the AUTO-PWR-MAN switch on the control circuit board assembly is operated to AUTO and the NORM-EXT switch is operated to NORM.

2-49. Refer to the final test data sheets shipped with the transmitter and ensure the AFC/PLL assembly SYNTHESIZER FREQUENCY SELECTION jumpers are correctly positioned.

2-50. Remove the two shipping screws securing the modulated oscillator assembly to allow the unit to float on the mountings.

2-51. Operate the exciter rear-panel POWER switch to ON.

2-52. Replace the exciter top-panel.

2-53. IPA Assembly. Remove the slide retainers from the IPA assembly.

2-54. Extend the IPA unit forward and remove the top-panel.

2-55. Refer to Figure 2-5 and ensure all jumpers are correctly positioned.

2-56. Replace the top-panel.

2-57. Optional Equipment. If the transmitter is equipped with the optional FS-30 stereo generator and the FC-30 SCA generator, refer to the FS-30 and FC-30 instruction manuals and perform any unpacking and programming checks described in SECTION II, INSTALLATION.

2-58. RF Enclosure. Open the cavity access door.

2-59. Disconnect the plate line B+ banana plug which is located along the left side of the plate-line.

2-60. Unpack the plate-line assembly by removing all tape and shims from the cavity shelf. Raise and rotate the plate-line to lock the plate-line in the up position.

2-61. Carefully remove all packing material from the tube socket.

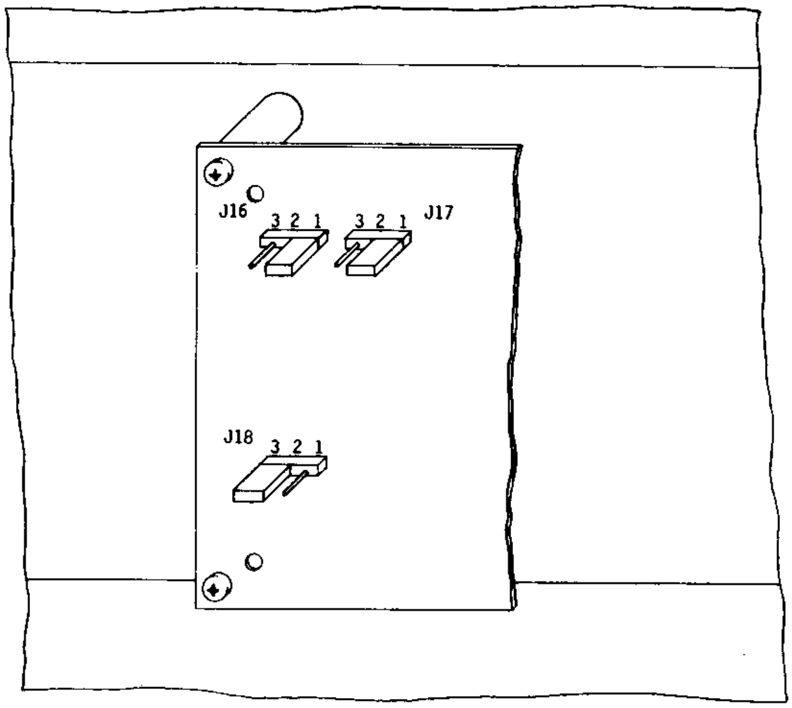

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FIGURE 2-5. IPA JUMPER PROGRAMMING

2-62. Carefully install the PA tube with a steady downward pressure. Do not rotate or rock the tube during installation to prevent damage to the tube socket.

2-63. After the PA tube is fully seated, rotate and slowly lower the plate-line over the PA tube until the plate-line shelf-stops engage the cavity shelf. The plate-line will cover approximately one-half of the tube anode when properly installed.

2-64. Align the plate-line connections and reconnect the B+ banana plug. Ensure all plate-line connections are secure.

2-65. Secure the plate-line to the tube with the strap clamp. The plate-line must not move from the PA tube when upward pressure is applied.

2-66. Close and lock the PA cavity access door.

NOTE ENSURE THE TRANSMITTER COARSE TUNING IS ADJUSTED IN THE FOLLOWING STEP.

2-67. Adjust the transmitter coarse tuning as follows:

A. On the top of the transmitter, loosen the PA tuning line clamp.

B. Raise the PA tuning line until the factory scribed line is aligned with the top of the cavity clamping flange. Secure the tuning line clamp.

C. Ensure the coarse PA INPUT TUNING cyclometer on the rear of the RF enclosure indicates the value listed on the factory final test data sheets and the control is locked.

2-68. Check the following components located on the rear of the RF enclosure.

A. Ensure the NEUT cyclometer indicates the value listed on the factory final test data sheets.

B. Ensure the second harmonic suppressor is adjusted to the factory preset scribed line on the adjustment control rod. If adjustment is required, loosen the two lock screws and adjust the suppressor in or out as required. Do not rotate suppressor during adjustment.

<u>CAUTION</u>
<u>CAUTION</u>
<u>CAUTION</u>
<u>CAUTION</u>

TO PREVENT INCREASED HARMONIC OUTPUT LEVELS AND EFFICIENCY DEGRADATION, ASSEMBLE THE TRANSMITTER OUTPUT LINE AS DESCRIBED IN THE FOLLOWING TEXT WITH THE COMPONENTS SUPPLIED BY THE FACTORY. DO NOT INSTALL ADDITIONAL TRANSMISSION LINE SECTIONS BETWEEN THE CAVITY OUTPUT PORT AND THE LOW-PASS FILTER.

2-69. <u>RF Output Line Assembly.</u> Refer to Figure 2-6 and the following information to assemble the transmitter RF output transmission line. Assemble the RF output line as described with the components supplied by the factory. Do not install additional transmission line sections between the cavity output port and the low-pass filter. Incorrect assembly may result in increased harmonic output levels and efficiency degradation.

2-70. Insert the long RF output transmission line section inner conductor through the support bracket into the bullet conductor of the lower elbow assembly.

2-71. Insert the long RF output transmission line section outer conductor through the support bracket into the lower elbow assembly.

2-72. Secure the lower transmission line assembly to the elbow with the strap clamp. Secure the four support bracket screws.

2-73. Insert the upper elbow assembly with the short transmission line section into the lower line section as shown. Secure the assembly with the strap clamp.

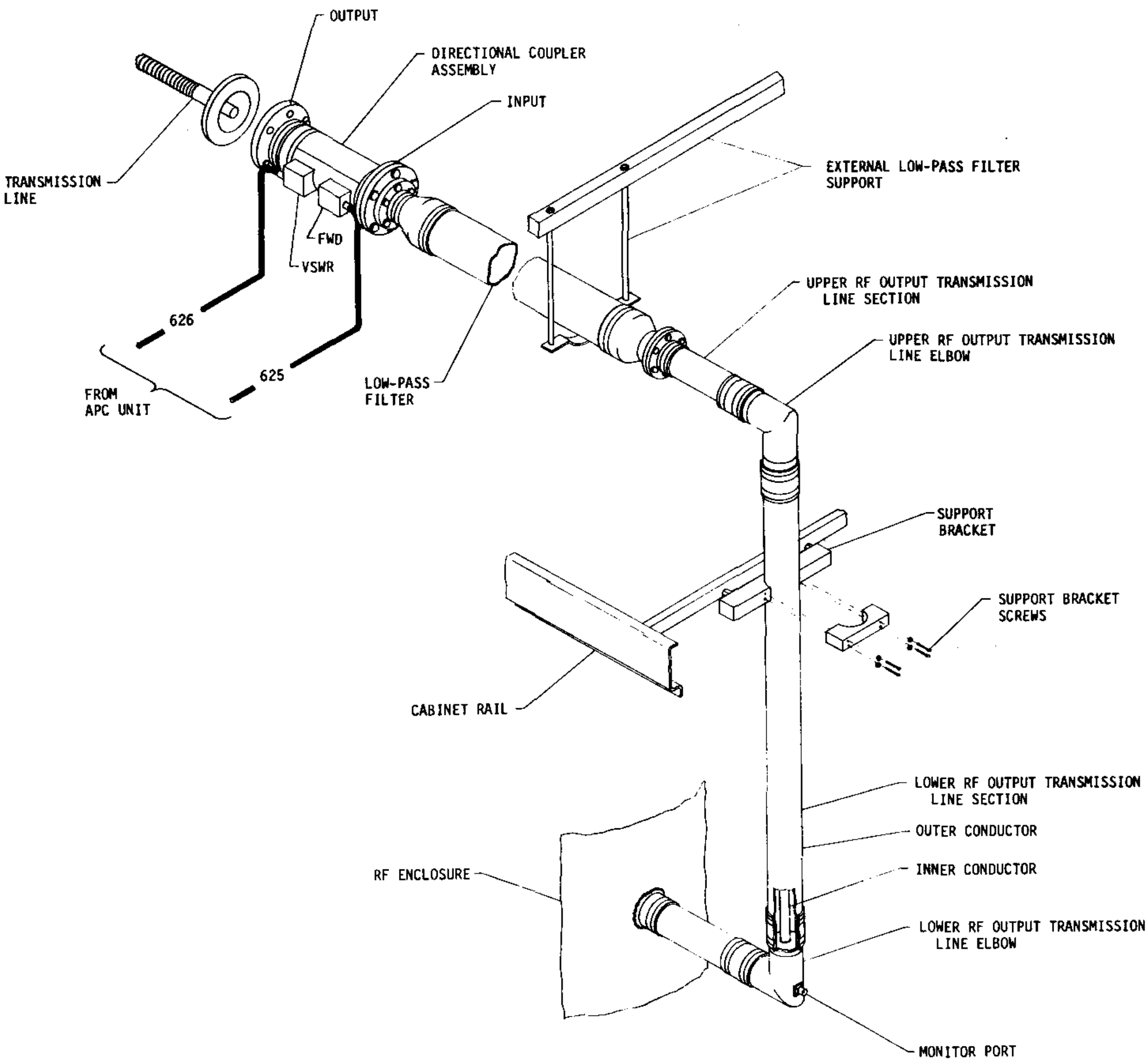

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FIGURE 2-6. FM-10A RF OUTPUT TRANSMISSION LINE ASSEMBLY

2-74. On a work surface, bolt the directional coupler assembly input to either end of the low-pass filter as shown. The directional coupler input and output connections are labeled to ensure correct installation.

<u>CAUTION</u> THE TRANSMITTER WILL NOT SUPPORT THE WEIGHT OF THE LOW-PASS FILTER ASSEMBLY. MECHANICAL SUPPORT EXTERNAL TO THE TRANSMITTER IS REQUIRED.
<u>CAUTION</u>

2-75. Using mechanical support external to the transmitter, mount and secure the low-pass filter assembly directly to the upper transmission line section.

2-76. Connect the following coaxial cables to the RF output line assembly:

A. Connect APC unit forward power cable 625 to the FWD port on the directional coupler.

B. Connect APC unit VSWR cable 626 to the VSWR port on the directional coupler.

C. Connect the station monitor cable to the monitor port on the output line assembly.

2-77. <u>Miscellaneous Assemblies.</u> Unpack the PA/driver cabinet grounding stick and the failsafe solenoid assembly as follows:

A. Unpack the PA/driver cabinet grounding stick and place the stick on the interlocked hanger. Ensure the ty-wrap securing the grounding stick hanger interlock switch is removed.

B. Remove the cover from the FAILSAFE SOLENOID ASSEMBLY and remove the ty-wraps from the solenoid plunger. Replace the assembly cover.

2-78. EXTENDED LOCAL CONTROL.

2-79. Extended local control of the FM-10A is provided up to a maximum of 100 feet (30.48 m) by the Broadcast Electronics optional master extended local control unit (BE P/N 909-0103). Refer to the extended local control panel instruction manual for installation procedures.

2-80. REMOTE CONTROL.

2-81. Many transmitter functions may be remotely controlled (see Figure 2-7). The transmitter will interface with most modern remote control units such as the sixteen channel Moseley MRC-1600. Programmable circuitry on the controller input filter circuit board provides either positive or negative logic remote indications to meet any interfacing requirement. The circuitry is shipped from the factory with negative remote indication logic and +2.5V dc full-scale remote meter indications. If re-programming of the transmitter remote indications is required, proceed as follows:

WARNING — ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.

A. Remove the REMOTE INDICATION PROGRAMMING access panel on the controller cabinet rear-panel.

B. Refer to Figure 2-7 and program the input filter circuit board for the desired remote indication logic and meter indications:

   1. Install the inverter integrated circuits in receptacles U1 and U2 for negative remote indication logic.

   2. Install the resistor network in receptacle R35 for +2.5 volt dc remote meter indications.

   3. Install 8-Pin DIP programmable jumpers in receptacles U1, U2, and R35 for positive remote indication logic and +5 volt dc remote meter indications.

C. Replace the access panel.

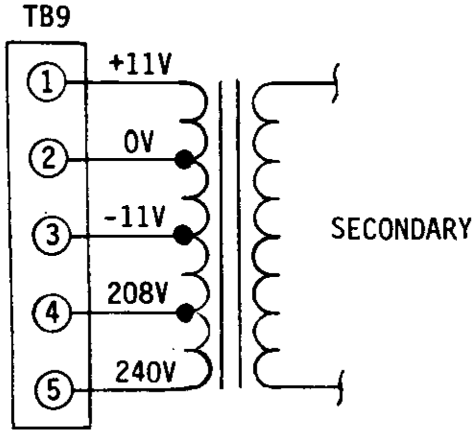
D. Complete the remote control installation by connecting the remote control unit wiring to the transmitter REMOTE INTERFACE PANEL terminal strips (refer to Figure 2-7).

2-82. WIRING.

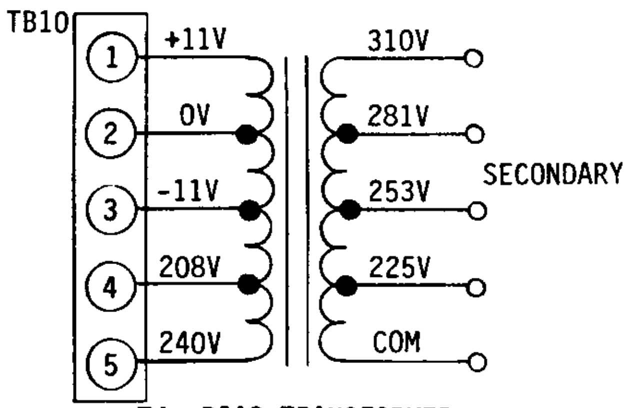
WARNING — ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.

2-83. VOLTAGE TAPS. Ensure the transmitter is wired for the input voltage and line frequency to be used. The screen transformer, the plate transformer, the bias transformer, and the filament transformer must be checked and changed if required (see Figure 2-8).

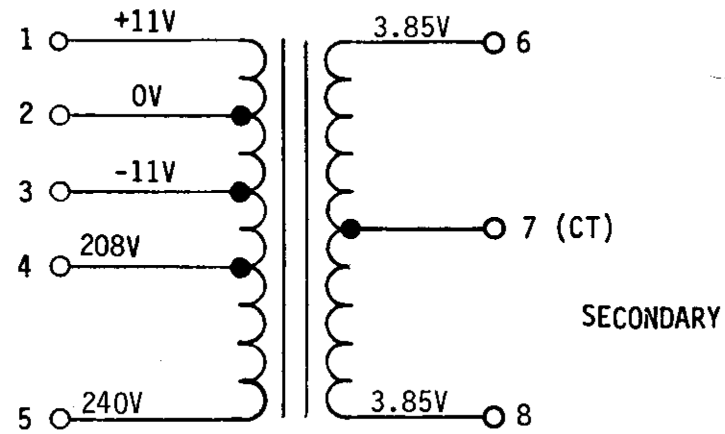
2-84. Check the IPA voltage taps per Figure 2-9 and change the wiring if required. Normally the taps are chosen to limit IPA regulator dissipation over the normal line voltage excursions. The 208-250V selection is typically acceptable.



T2--SCREEN TRANSFORMER



T4--BIAS TRANSFORMER



T5--FILAMENT TRANSFORMER

CAUTION

AFTER RETAPPING THE FILAMENT TRANSFORMER, THE CORRECT FILAMENT VOLTAGE MUST BE OBTAINED WITH THE FILAMENT ADJUST CONTROL NEAR THE CENTER OF ITS RANGE.

PLATE TRANSFORMER

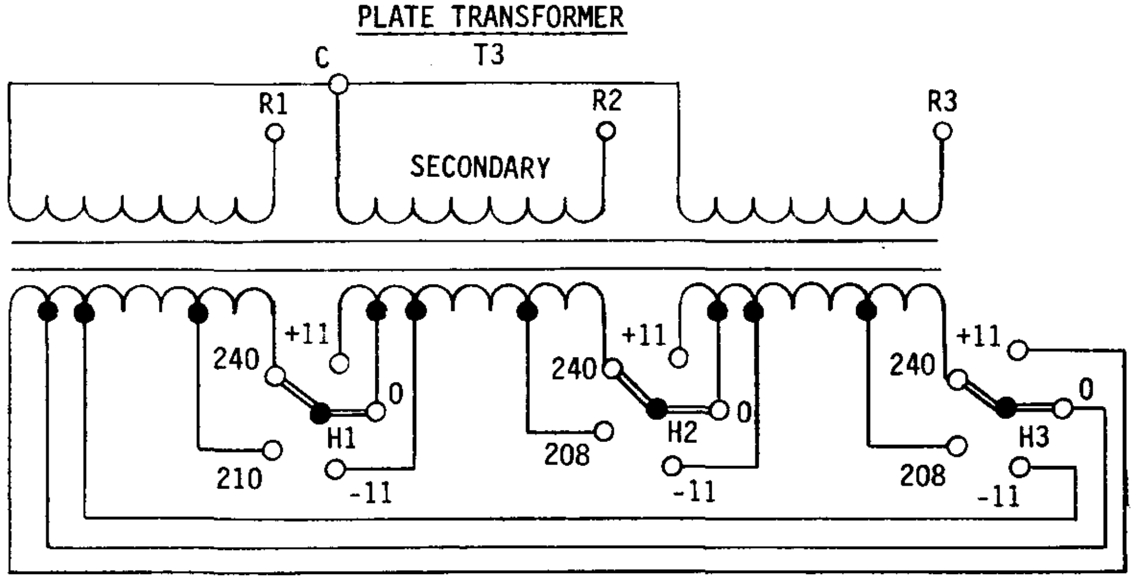


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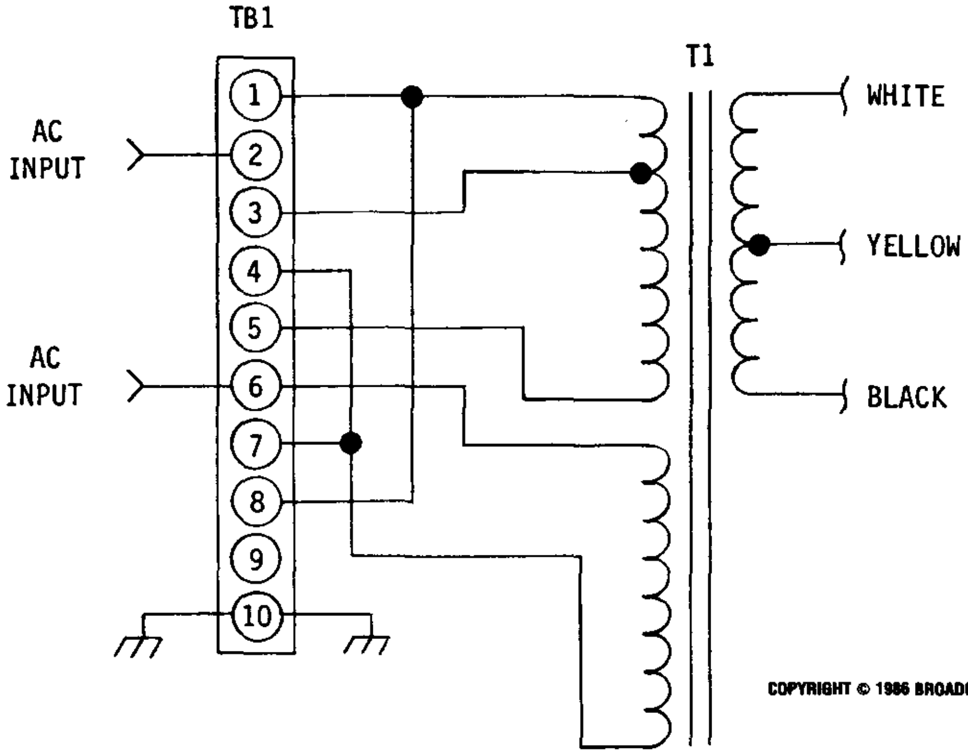
FIGURE 2-8. TRANSFORMER TAPS



LINE VOLTAGE	JUMPER	SECONDARY WIRING
194-223V	2-3, 4-5, 8-9	BLACK AND WHITE
213-256V	2-3, 4-5, 8-9	BLACK AND YELLOW
208-250V	1-2, 4-5, 8-9	BLACK AND WHITE
229-275V	1-2, 4-5, 8-9	BLACK AND YELLOW

597-0098-10

FIGURE 2-9. IPA VOLTAGE TAPS

WARNING: ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.

2-85. INPUT VOLTAGE CHECK. Check the transmitter controller, FM exciter, the optional stereo generator, and the optional SCA generator ac input voltages as follows:

A. The primary ac line voltage with which the transmitter will be used (208V or 230/240V) must be visible on the ac line voltage selector circuit board located adjacent to the ac input connector on each unit.

B. If an ac line voltage selector must be changed, remove the ac line voltage selector circuit board with a small pair of needle-nose pliers. Reinsert the circuit board so that the correct ac line voltage is visible when the circuit board is reinserted into the receptacle.

WARNING ENSURE NO PRIMARY POWER IS CONNECTED TO THE TRANSMITTER BEFORE PROCEEDING.

2-86. CABINET INTERCONNECTIONS. Refer to the following cabinet interconnection procedures for the type of transmitter installation used.

2-87. Cabinet Interconnections For Adjacent Power Supply Cabinet Installation. For an adjacent power supply cabinet installation, refer to Figure 2-10 and perform the following cabinet interconnections:

A. Connect wires 631 through 640 to TB15 in the PA/driver cabinet.

B. Attach interlock connector P15 to J15.

C. Connect high voltage wires 644 and 645 to resistor R14 and the meter multiplier circuit board assembly in the power supply cabinet as shown.

WARNING ENSURE ALL CABINET GROUND CONNECTIONS ARE PERFORMED IN THE FOLLOWING STEP.

D. Attach the ground connections in the cabinets as follows:

1. Connect the appropriate size braided copper wire or 2 inch wide (5.08 cm) copper strap from earth ground to the power supply cabinet ground strap as shown.

2. Bolt the power supply cabinet ground strap to the PA/driver cabinet ground strap as shown.

2-88. Cabinet Interconnections For Remote Power Supply Cabinet Installation. For a remote power supply cabinet installation, refer to Figure 2-11 and perform the following cabinet interconnections:

WARNING

WARNING

ROUTE CABINET INTERCONNECTING HIGH VOLTAGE AND AC POWER CABLES IN 1 INCH (2.54 cm) METALLIC CONDUIT TO PREVENT EXPOSURE TO HAZARDOUS VOLTAGES.

A. Using the cabinet under-floor or overhead wiring access holes, route the high voltage and ac power cables from the power supply cabinet to the PA/driver cabinet through 1 inch (2.54 cm) metallic conduit.

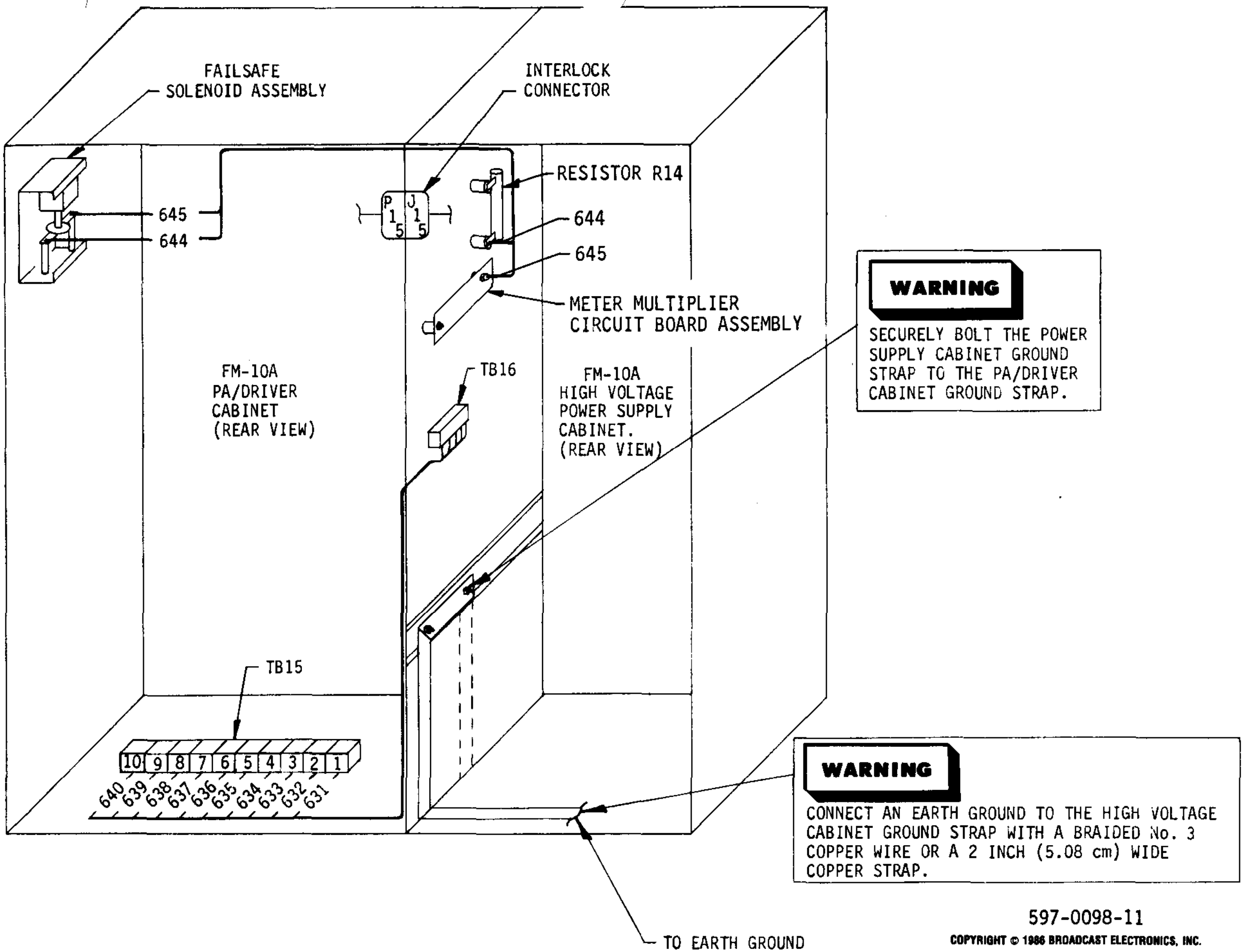


FIGURE 2-10. CABINET INTERCONNECTIONS, ADJACENT POWER SUPPLY CABINET INSTALLATION

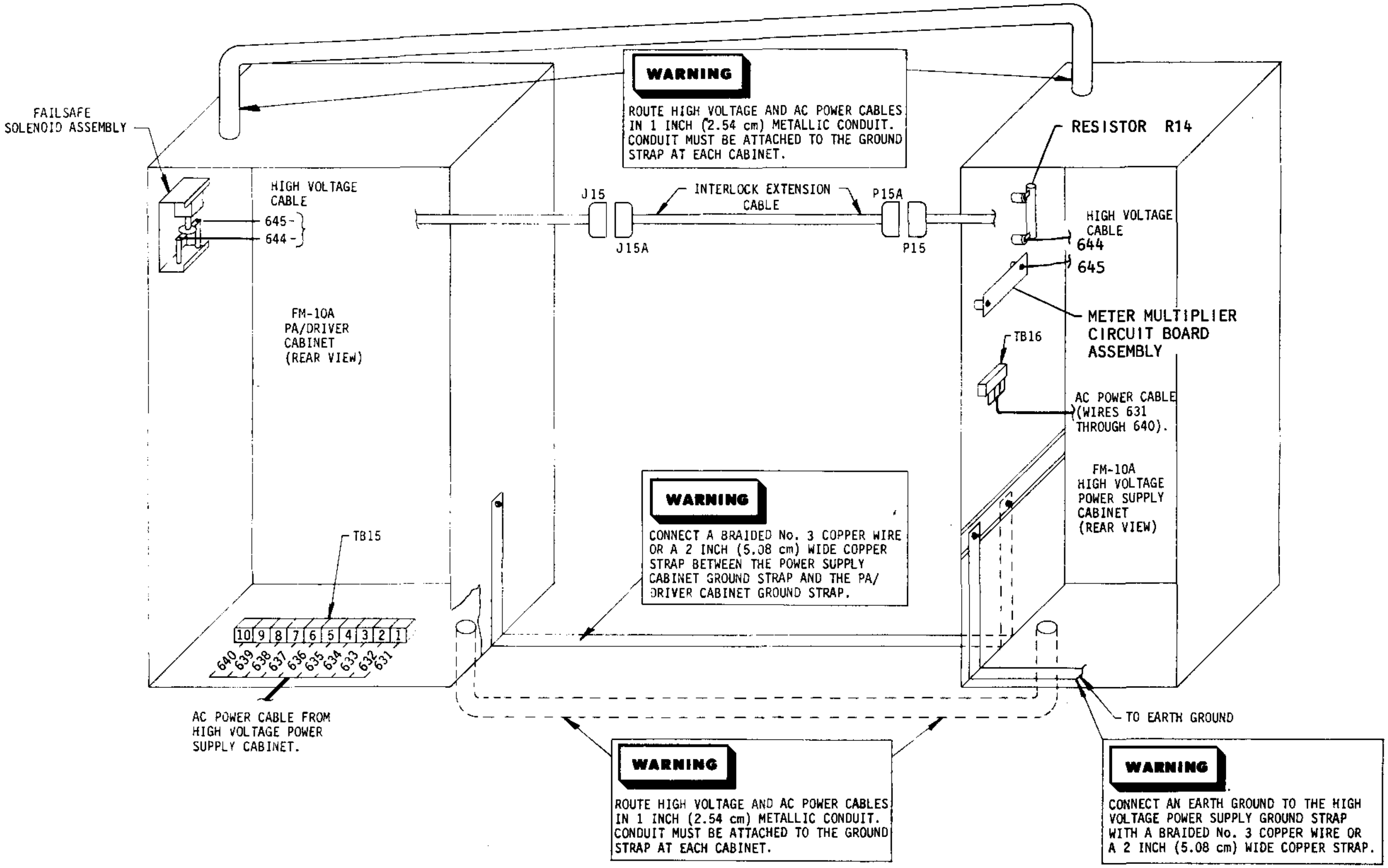


FIGURE 2-11. CIRCUIT INTERCONNECTIONS, REMOTE POWER SUPPLY CABINET INSTALLATION

597-0098-12

WARNING CONNECT THE CONDUIT TO THE GROUND STRAP IN EACH CABINET.

B. Connect the conduit to the ground strap in each cabinet.

C. Connect ac power wires 631 through 640 to TB15 in the PA/driver cabinet.

D. Connect the interlock extension cable between J15 and P15.

E. Connect high voltage wires 644 and 645 to resistor R14 and the meter multiplier circuit board assembly in the power supply cabinet as shown.

WARNING ENSURE ALL CABINET GROUND CONNECTIONS ARE PERFORMED IN THE FOLLOWING STEP.

F. Attach the ground connections in the cabinets as follows:

1. Connect the appropriate size braided copper wire or 2 inch wide (5.08 cm) copper strap from earth ground to the power supply cabinet ground strap as shown.

2. Connect the appropriate size braided copper wire or 2 inch wide (5.08 cm) copper strap from the power supply cabinet ground strap to the PA/driver cabinet ground strap as shown.

2-89. OPTIONAL EQUIPMENT WIRING. Mount and wire any optional equipment not provided with the transmitter. Figure 2-12 illustrates the ac power connections for the optional equipment.

2-90. SIGNAL INPUTS. Refer to the applicable technical manual for the exciter, stereo generator, and SCA generator and wire the inputs and control connections to each unit.

2-91. EXTERNAL INTERLOCK. The FM-10A is equipped with an external interlock circuit such as for a test load or remote control fail-safe connection. The external interlock circuit is independent of the transmitter safety interlock circuit and will disable only the high voltage plate supply when opened. The external interlock circuit however may be programmed to completely deenergize the transmitter. If the external interlock circuit is required to completely deenergize the transmitter, proceed as follows:

A. Remove the EXTERNAL INTERLOCK PROGRAMMING access panel on the controller cabinet rear-panel.

B. Refer to input filter circuit board assembly diagram AD919-0056 in PART II, TRANSMITTER CONTROLLER and install jumper J7 in position 2-3.

C. Replace the access panel.

2-92. If an external interlock is desired, refer to Figure 2-13 and remove the jumper between TB3-6 and TB3-7. Install a normally closed interlock switch and interlock indicator as shown. The interlock must be electrically isolated from ground, any ac, or any dc potentials. If unused, ensure the factory installed jumper is connected between the terminals.

WARNING ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-93. AC POWER CONNECTIONS. A three-phase power source of 197 to 251V ac, 50/60 Hz or 341 to 435V ac, 50 Hz at 100 Amperes per phase is required for transmitter operation. Ensure the power source is supplied from an acceptable ac transformer configuration (refer to PRIMARY POWER). For operating safety, the power source must be routed to the transmitter through a fused power disconnect (see Figure 2-14).

WARNING ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-94. Main ac Input. Refer to Figure 2-14 and connect the 100 Ampere three-phase service to ac input terminal strip TB1 in the high voltage power supply cabinet through a fused service disconnect. Ensure a utility company ground conductor is securely connected to the power supply cabinet ground lug. For a three-phase WYE service, ensure the neutral wire is connected to ac input terminal TB1-1.

2-95. INITIAL CHECKOUT.

WARNING ENSURE ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-96. Replace all panels and doors etc. on the transmitter.

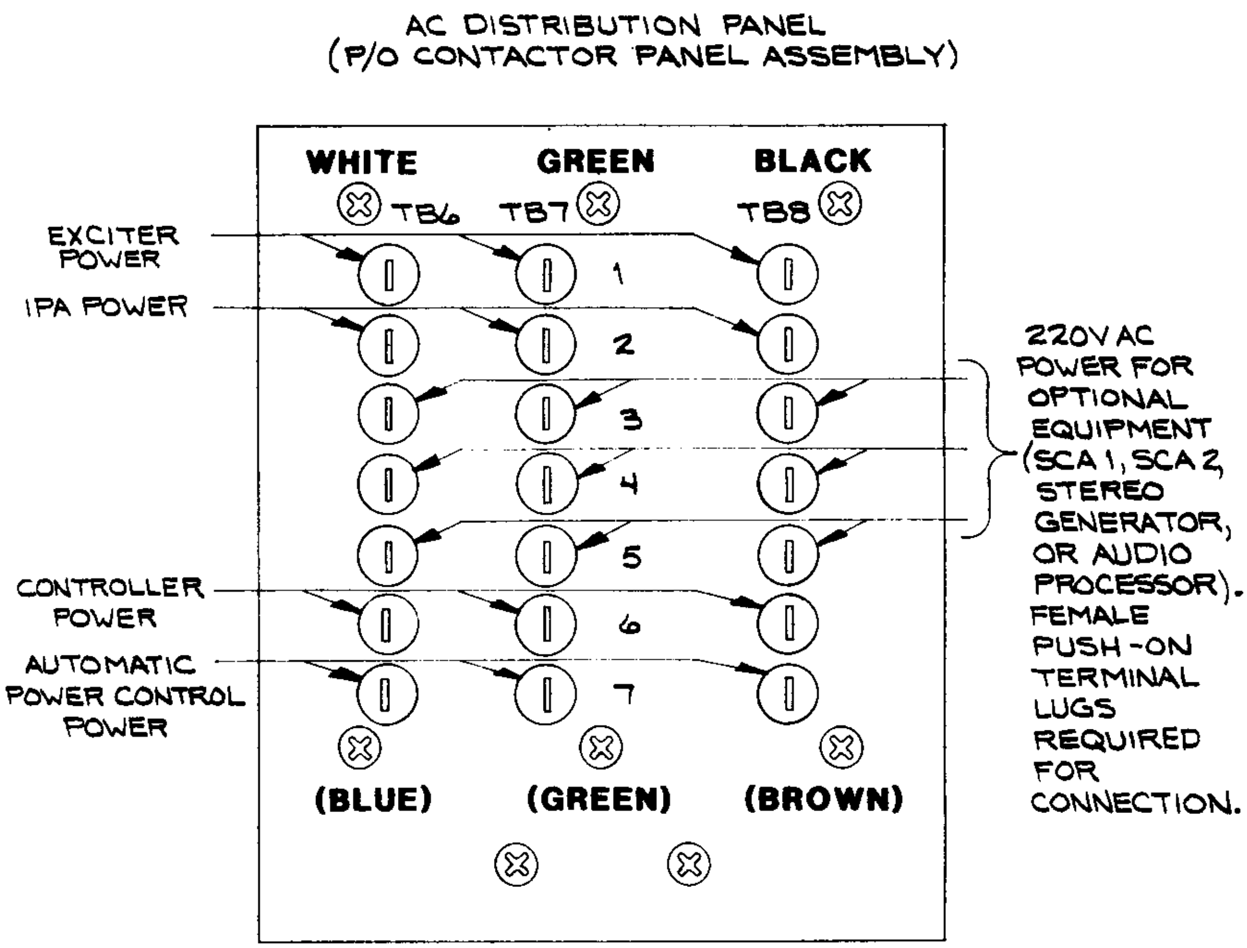
2-97. Ensure the transmitter is completely installed by checking the following items:

A. Ensure primary power is correctly wired.

B. Ensure all ground connections are secure.

C. Ensure the cabinet ground straps are properly connected to earth ground.

D. Ensure all RF connections are secure.



597-0098-13

FIGURE 2-12. OPTIONAL EQUIPMENT WIRING

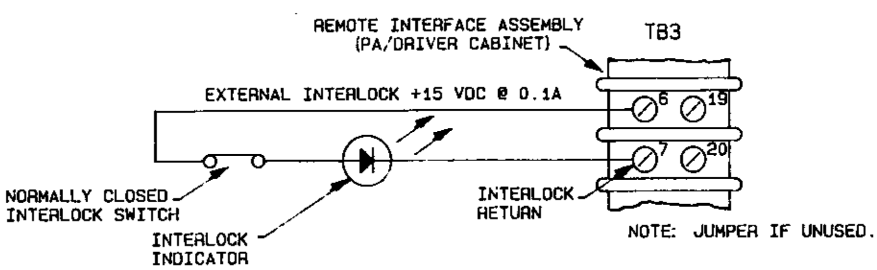


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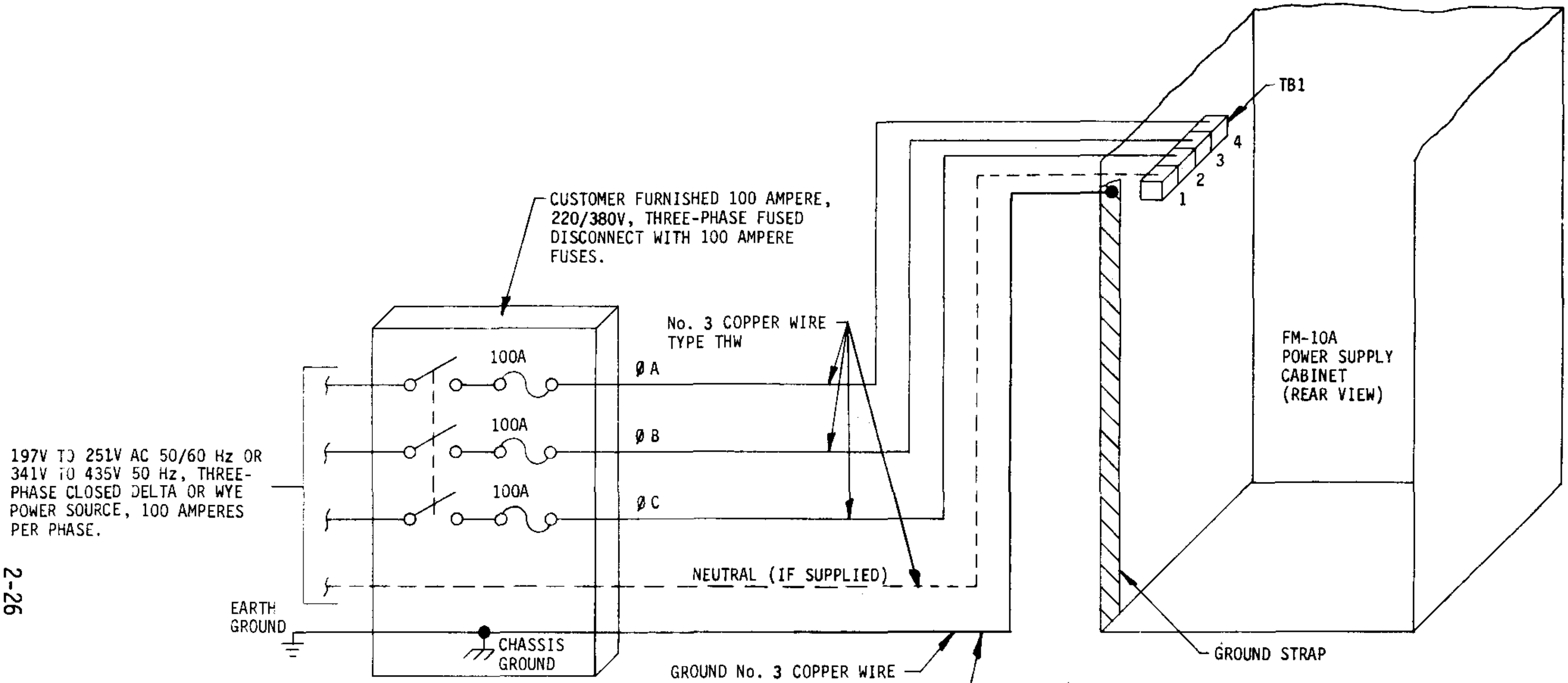
FIGURE 2-13. EXTERNAL INTERLOCK CIRCUIT



WARNING

IF THE POWER SUPPLY CABINET IS LOCATED REMOTELY FROM THE PA/DRIVER CABINET, ENSURE A No. 3 COPPER WIRE OR A 2 INCH (5.08 cm) WIDE COPPER STRAP IS CONNECTED FROM THE POWER SUPPLY CABINET GROUND STRAP TO THE PA/DRIVER CABINET GROUND STRAP.

WARNING

ENSURE AN EARTH GROUND IS CONNECTED TO THE POWER SUPPLY CABINET GROUND STRAP WITH BRAIDED No. 3 COPPER WIRE OR A 2 INCH (5.08 cm) WIDE COPPER STRAP.

597-0098-14

FIGURE 2-14. PRIMARY AC WIRING

E. Ensure the station monitor is properly connected to the transmission line RF sample port.

F. Ensure all connections at terminal boards are secure.

G. Rotate the blower and fans by hand to ensure no obstructions are present.

H. Using an insulator, check relay operation manually to be certain all have free movement.

I. Remove any extra hardware and wire lying within the cabinets.

J. Ensure all guards at terminal strips, circuit breakers etc. are secure.

K. Using a minature flat-blade screwdriver, mechanically zero all meters.

L. Ensure the transmitter shorting sticks are on the hangers and close all doors.

2-98. Operate all six front-panel circuit breakers to OFF and ensure all transmitter controls are preset to the positions indicated on the final test data sheets.

2-99. Ensure an RF load is connected to the transmitter.

2-100. Adjust the transmitter FILAMENT VOLTAGE control fully counterclockwise (minimum).

2-101. Extend the exciter forward to expose the RF OUTPUT ADJ. control access hole in top-panel. Adjust the control fully counterclockwise (minimum).

2-102. The following procedure will refer to the factory final test data sheets supplied with the transmitter. Some differences in the actual operation may be noted due to differences in primary power or antenna systems.

2-103. CONTROLLER AND INTERLOCK CHECKOUT. Check the controller and the transmitter interlock circuit by performing the following procedures.

2-104. <u>Controller Checkout.</u> Close the wall-mounted fused disconnect.

2-105. Operate the CONTROL and BLOWER circuit breakers to ON. The HIGH VOLTAGE, DRIVER, SCREEN, and FILAMENT circuit breakers must remain OFF.

2-106. Ensure the FILAMENT ON and HIGH VOLTAGE ON switch/indicators are extinguished.

2-107. Open the controller cabinet door and check the following items on the controller circuit board.

A. Ensure the POWER indicator is illuminated.

B. Depress the BATTERY TEST switch. The TEST indicator will illuminate.

2-108. Interlock Checkout. Complete the following procedure step by step and note the controller INTERLOCK STATUS indicator. If problems occur, deenergize all primary power and troubleshoot the series interlock circuit with an Ohmmeter.

2-109. Ensure the CONTROL and BLOWER circuit breakers are operated to ON and the HIGH VOLTAGE, DRIVER, SCREEN, and FILAMENT circuit breakers are operated to OFF.

WARNING DEENERGIZE PRIMARY POWER BEFORE PROCEEDING.

2-110. Operate the CONTROL circuit breaker to OFF.

2-111. Remove the PA/driver cabinet lower front access panel.

WARNING DO NOT TOUCH ANYTHING WITHIN THE TRANSMITTER WITH POWER ENERGIZED.

2-112. Operate the CONTROL circuit breaker to ON. The controller INTERLOCK STATUS indicator will be extinguished.

WARNING DEENERGIZE PRIMARY POWER BEFORE PROCEEDING.

2-113. Operate the CONTROL circuit breaker to OFF.

2-114 Replace the PA/driver cabinet lower front access panel.

2-115. Operate the CONTROL circuit breaker to ON. The controller INTERLOCK STATUS indicator will illuminate.

2-116. Open the PA/driver cabinet rear door. The controller INTERLOCK STATUS indicator will extinguish.

2-117. Close the PA/driver cabinet rear door. The controller INTERLOCK STATUS indicator will illuminate.

2-118. Open the PA/driver cabinet rear door and perform the following:

WARNING PERFORM THE FOLLOWING PROCEDURES AS INDICATED. DO NOT TOUCH ANYTHING WITHIN THE TRANSMITTER WITH POWER ENERGIZED. WARNING

A. Depress the PA/driver cabinet rear door interlock switch and raise the cabinet grounding stick from the hanger. The controller INTERLOCK STATUS indicator will extinguish.

B. Replace the grounding stick. The controller INTERLOCK STATUS indicator will illuminate.

C. While depressing the PA/driver cabinet rear door interlock switch, open the PA cavity access door. The controller INTERLOCK STATUS indicator will extinguish.

D. Close the PA cavity access door. The controller INTERLOCK STATUS indicator will illuminate.

E. Close the PA/driver cabinet rear door.

2-119. Open the power supply cabinet rear door. The controller INTERLOCK STATUS indicator will extinguish.

2-120. Close the power supply cabinet rear door. The controller INTERLOCK STATUS indicator will illuminate.

2-121. Open the power supply cabinet rear door and perform the following:

WARNING PERFORM THE FOLLOWING PROCEDURES AS INDICATED. DO NOT TOUCH ANYTHING WITHIN THE TRANSMITTER WITH POWER ENERGIZED. WARNING

A. Depress the power supply cabinet rear door interlock switch and raise the cabinet grounding stick from the hanger. The controller INTERLOCK STATUS indicator will extinguish.

B. Replace the grounding stick. The controller INTERLOCK STATUS indicator will illuminate.

C. Close the power supply cabinet rear door.

2-122. If an external interlock switch and indicator is installed, check the operation as follows:

A. Open the external interlock. The external interlock indicator will extinguish.

B. Close the external interlock. The external interlock indicator will illuminate.

2-123. BLOWER CHECKOUT. Check blower operation by performing the following procedure.

2-124. Ensure the CONTROL and BLOWER circuit breakers are operated to ON. The HIGH VOLTAGE, DRIVER, SCREEN, and FILAMENT circuit breakers must remain OFF.

2-125. Depress the FILAMENT ON switch/indicator to illuminate the switch/indicator. The FILAMENT ON switch/indicator, BLOWER STATUS, and the FILAMENT STATUS indicators will illuminate and the blower will begin operation.

2-126. Ensure the blower, BLOWER STATUS indicator, and the FILAMENT STATUS indicator are operating properly. At high altitudes, the BLOWER STATUS indicator may not illuminate. If this occurs, proceed as follows:

<u>WARNING</u>: ENSURE PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

A. Disconnect primary ac power by opening the wall-mounted fused disconnect.

B. Open the transmitter rear door.

C. Using a flat-tip screwdriver, remove the two blower air switch mounting screws. Turn the air switch over so that the adjustment may be accessed, then re-mount the air switch.

D. Using a miniature flat-tip screwdriver, adjust the air switch adjustment slightly counterclockwise.

E. Attempt transmitter operation.

F. If required, disconnect primary power and repeat the adjustment.

2-127. EXCITER CHECKOUT. Check exciter operation by performing the following procedure.

2-128. Ensure the CONTROL and BLOWER circuit breakers are operated to ON.

2-129. Operate the DRIVER circuit breaker to ON. The HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers must remain OFF.

2-130. Depress the HIGH VOLTAGE ON switch/indicator to illuminate the switch/indicator.

2-131. Apply audio to the exciter. The presence of audio programming will be noted on the exciter digital MODULATION meter. The AFC and POWER indicators will illuminate.

2-132. Depress the exciter multimeter +20 switch.

A. The multimeter should indicate +20 volts ±2 volts.

2-133. Depress the exciter multimeter -20 switch.

A. The multimeter should indicate -20 volts ±2 volts.

2-134. Depress the exciter multimeter +5 switch.

A. The multimeter should indicate +5 volts ±0.5 volts.

2-135. Depress the exciter multimeter AFC switch.

A. The multimeter should indicate a potential within the range of +2.5 volts to +13.5 volts, dependent upon carrier frequency. The correct voltage is noted on the final test data sheets.

2-136. Depress the exciter multimeter FWD switch.

2-137. Depress the FILAMENT OFF switch.

2-138. Remove the audio from the exciter.

2-139. PRELIMINARY OPERATION AND TUNING. Operate and tune the transmitter by performing the following procedure.

2-140. Ensure the CONTROL, BLOWER, and DRIVER circuit breakers are operated to ON. The HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers must remain OFF.

2-141. Ensure the controller INTERLOCK STATUS indicator is illuminated. If the INTERLOCK STATUS indicator is extinguished, open the wall-mounted fused disconnect and check the following:

A. All panels are installed.
B. All shorting sticks are on the hangers.
C. All doors are closed.

2-142. If installed, ensure the external interlock indicator is illuminated. If the external interlock indicator is extinguished, open an appropriate power source disconnect if required and check the interlock switch.

2-143. Ensure the FILAMENT ON and HIGH VOLTAGE ON switch/indicators are extinguished.

2-144. Depress the APC ON switch/indicator to extinguish the switch/indicator.

2-145. Depress the APC REMOTE DISABLE switch/indicator to illuminate the switch/indicator.

2-146. Operate the APC FORWARD POWER METER switch to FWD.

CAUTION ENSURE AN RF LOAD IS CONNECTED TO THE TRANSMITTER AND THE FILAMENT VOLTAGE CONTROL IS FULLY COUNTERCLOCKWISE. CAUTION

2-147. Operate the FILAMENT circuit breaker to ON.

2-148. Depress the FILAMENT ON switch/indicator. Both the FILAMENT ON switch/indicator and the FILAMENT STATUS indicator will illuminate and the blower will begin operation.

2-149. Adjust the FILAMENT ADJUST control to obtain a FILAMENT VOLTAGE meter indication of 7.0 volts.

2-150. Verify the GRID VOLTAGE meter indication without drive (refer to the factory test data sheets).

2-151. Depress the RAISE switch/indicator for approximately three seconds. The switch/indicator will flash.

2-152. Depress the APC ON switch/indicator to illuminate the switch/indicator. The LOWER switch/indicator will flash until the APC returns the screen variable auto-transformer to minimum.

2-153. Depress the APC ON switch/indicator. The switch/indicator will extinguish.

2-154. Operate the SCREEN and HIGH VOLTAGE circuit breakers to ON.

2-155. Depress the HIGH VOLTAGE ON switch/indicator. Both the HIGH VOLTGE ON switch/indicator and the HIGH VOLTAGE STATUS indicator will illuminate.

2-156. Adjust the exciter output to approximately five Watts.

2-157. Depress the exciter multimeter PAV switch.

A. The multimeter will indicate a potential within the range of +6.5 volts to +7.5 volts (assuming an RF output power of 5 Watts).

2-158. Depress the exciter multimeter PAI switch.

A. The multimeter will indicate approximately 1.5 amperes (assuming RF output power of 5 Watts).

2-159. Depress the exciter multimeter FWD switch.

2-160. Adjust the INPUT TUNING control to obtain a maximum indication on the GRID CURRENT meter.

2-161. Adjust the exciter output to approximately 7.5 Watts.

2-162. The IPA FWD POWER indicator will illuminate. If the IPA VSWR indicator illuminates during the remainder of the initial checkout procedure, this indicates that the IPA load is incorrect. To correct the situation, readjust the INPUT TUNING control for a maximum indication on the GRID CURRENT meter.

2-163. The OUTPUT POWER meter will indicate a low level of less than 20% full-scale.

2-164. Adjust the OUTPUT TUNING control for a maximum OUTPUT POWER meter indication.

2-165. Depress the APC RAISE switch/indicator. The switch/indicator will flash. Hold the switch/indicator depressed until the OUTPUT POWER meter indicates 25% power.

2-166. Adjust the OUTPUT TUNING control for a maximum OUTPUT POWER meter indication.

2-167. Adjust the INPUT TUNING control to obtain a maximum indication on the GRID CURRENT meter.

2-168. Depress the APC RAISE switch/indicator. Hold the switch/indicator depressed until a 50% indication is obtained on the OUTPUT POWER meter.

2-169. Depress and hold the APC OUTPUT POWER meter switch to VSWR CAL. Adjust the VSWR CAL control for a 50% indication on the OUTPUT POWER meter.

2-170. Release the APC OUTPUT POWER METER switch. The OUTPUT POWER meter must indicate a VSWR of less than 1.2. An excessive VSWR indicates improper load connections.

2-171. Operate the OUTPUT POWER METER switch to FWD.

2-172. Adjust the OUTPUT TUNING for a maximum indication on the OUTPUT POWER meter, concurrent with a minimum indication on the PLATE CURRENT meter.

2-173. Adjust the exciter RF output power to the value stated on the factory test data sheets.

2-174. Depress and hold the APC RAISE switch/indicator. Hold the switch/indicator depressed until a 100% power indication is noted on the OUTPUT POWER meter. If a plate or screen current overload occurs, it may be necessary to adjust the OUTPUT LOADING for better efficiency before increasing power to 100%.

2-175. Adjust the OUTPUT LOADING and OUTPUT TUNING controls to obtain the values stated on the factory test data sheets.

2-176. Check the FILAMENT VOLTAGE meter and adjust the FILAMENT ADJUST control as required. The meter must indicate 7.0 volts.

2-177. Peak the INPUT TUNING for a maximum indication on the GRID CURRENT meter.

CAUTION DO NOT EXCESSIVELY UNLOAD THE PA CIRCUIT IN THE FOLLOWING STEP.

2-178. Adjust the PA stage for the most efficient operation with the OUTPUT TUNING and OUTPUT LOADING controls.

2-179. Depress the APC RAISE or LOWER switch/indicators as required to obtain a 100% OUTPUT POWER METER indication.

2-180. Compare the meter indications to those provided on the final test data sheets. All meter indications should be approximately the same as those stated on the final test data sheets.

2-181. Depress the APC ON switch/indicator. The switch/indicator will illuminate and the transmitter will maintain a constant 100% rated RF output.

2-182. Recalibrate the VSWR CAL control for a 100% RF output.

2-183. If an external interlock is installed, open the external interlock. The HIGH VOLTAGE STATUS indicator will extinguish and the PA plate voltage will be removed.

2-184. Close the external interlock. PA plate voltage will be restored, the transmitter will resume operation, and the HIGH VOLTAGE STATUS indicator will illuminate.

2-185. To adjust the automatic power control unit to maintain a level other than 100%, the APC ON switch/indicator must be illuminated. Depress and hold either the RAISE or the LOWER switch/indicator as desired until the desired percentage of transmitter power output is indicated by the OUTPUT POWER meter. The automatic power control circuitry operates in small increments and will take some time to track the reference to the new set point. The automatic power control circuitry will then maintain this new established RF output level. The VSWR CAL control must be re-calibrated and the transmitter must be retuned for maximum efficiency at this new level.

2-186. If remote operation is desired, the REMOTE DISABLE switch/indicator must be extinguished. TB2-29 on the remote interface terminal strip carries a remote enabled signal which can be connected to a relay or logic circuit to control a light or alarm to remind the engineer of the status of the remote disable switch. This feature will hopefully prevent inadvertent remote lockout if the engineer should leave the transmitter site and forget to enable remote operation.

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. This section identifies all controls and indicators associated with the FM-10A FM transmitter and provides standard operating procedures.

3-3. CONTROLS AND INDICATORS.

3-4. Refer to Figures 3-1 and 3-2 for the location of all controls and indicators associated with normal operation of the FM-10A transmitter. The function of each control or indicator is described in Tables 3-1 and 3-2.

3-5. OPERATION.

NOTE — THE FOLLOWING PROCEDURE IS PRESENTED UNDER THE ASSUMPTION THAT THE TRANSMITTER IS COMPLETELY INSTALLED AND IS FREE OF ANY DISCREPANCIES. — NOTE

3-6. TURN ON.

3-7. Operate all circuit breakers to ON.

3-8. Depress the REMOTE DISABLE switch/indicator to illuminate the switch/indicator.

3-9. Depress the FILAMENT ON switch/indicator, then depress the HIGH VOLTAGE ON switch/indicator. Each switch/indicator will illuminate as it is depressed.

3-10. If all interlocks are closed, the transmitter will be operational after a short delay to allow PA tube filament warm-up.

3-11. Check and log all meter indications and the status of the various indicators to assure proper equipment operation. A sample log sheet is provided in Table 3-3.

3-12. Operate the OUTPUT POWER METER switch to FWD to check the forward power output. To check VSWR, proceed as follows:

A. Depress and hold the OUTPUT POWER meter switch to VSWR CAL.

B. Adjust the VSWR CAL control to obtain a 100% indication on the OUTPUT POWER meter.

C. Release the OUTPUT POWER METER switch to check VSWR.

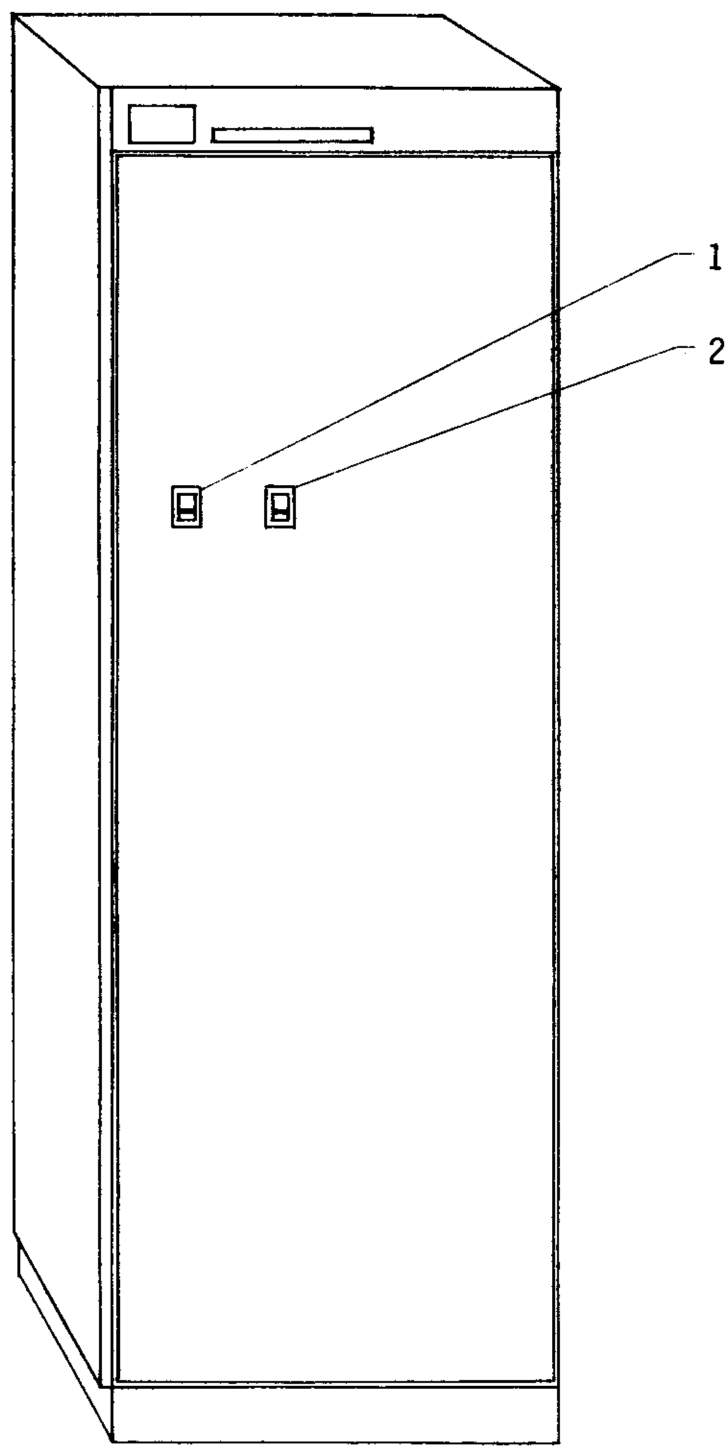


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FIGURE 3-1. FM-10A POWER SUPPLY CABINET CONTROLS AND INDICATORS

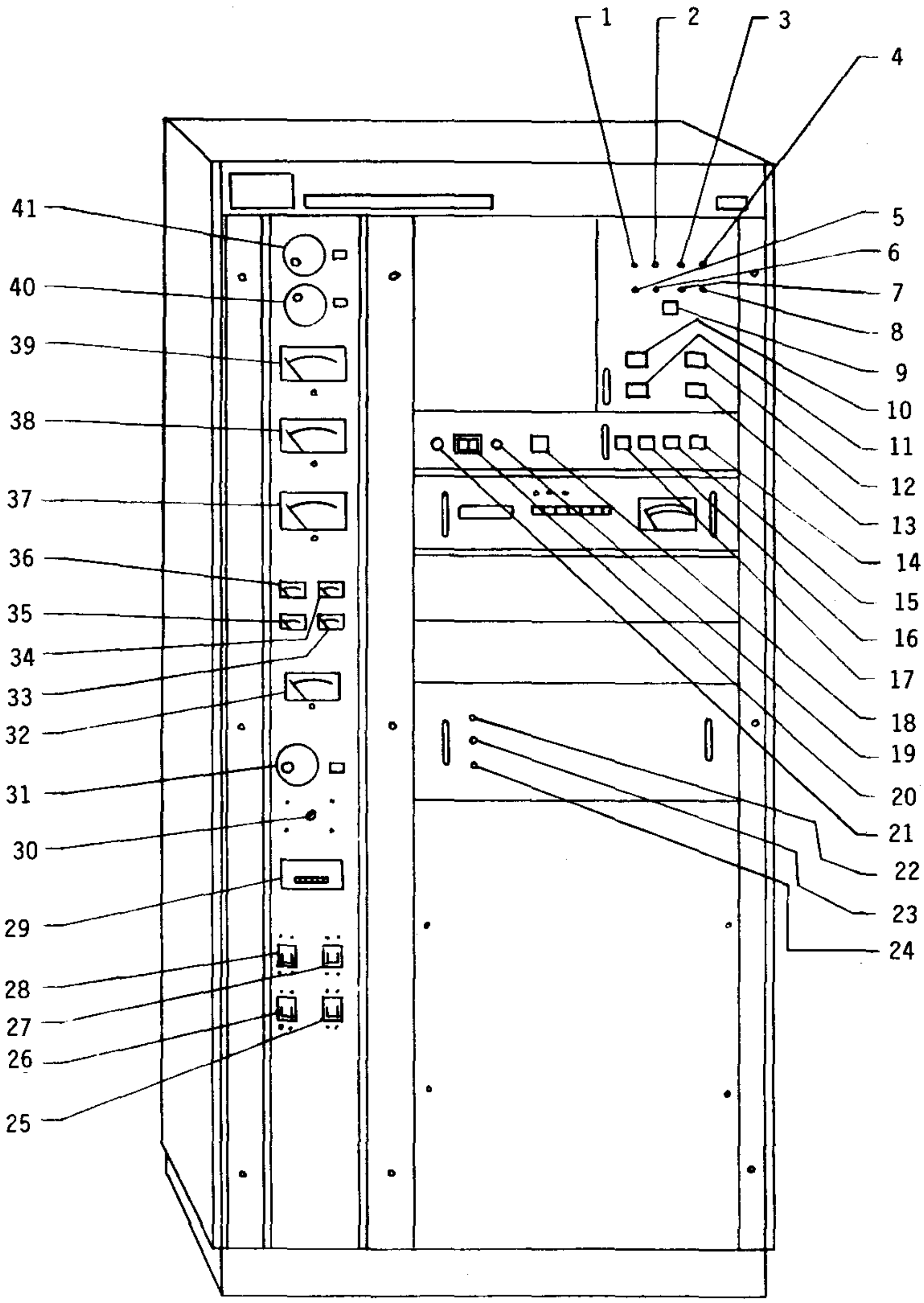

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FIGURE 3-2. FM-10A PA/DRIVER CABINET CONTROLS AND INDICATORS

3-13. Select the type of RF output power control:

A. If manual power control is desired, proceed as follows:

1. Depress the APC ON switch/indicator to extinguish the switch/indicator.

2. Depress the APC RAISE or LOWER switch/indicator to raise or lower the transmitter RF output power as indicated by the OUTPUT POWER meter.

B. If automatic power control is desired, depress the APC ON switch/indicator to illuminate the switch/indicator. To adjust the level at which the automatic power control circuitry will maintain, proceed as follows:

1. Depress the APC ON switch/indicator to illuminate the switch/indicator.

2. Depress and hold the APC RAISE or LOWER switch/indicator to establish a new RF power output level as indicated by the OUTPUT POWER meter.

3-14. If remote operation is desired, depress the REMOTE DISABLE switch/indicator to extinguish the switch/indicator. This will enable both local and remote operation.

3-15. TURN OFF.

3-16. Depress the FILAMENT OFF switch/indicator. After a period of blower operation to allow the PA tube to cool, the equipment will de-energize.

3-17. If the transmitter is disconnected from ac for longer than one day, remove the controller battery.

TABLE 3-1. FM-10A POWER SUPPLY CABINET CONTROLS AND INDICATORS

INDEX NO.	NOMENCLATURE	FUNCTION
1	HIGH VOLTAGE Circuit Breaker	Provides overload protection and primary power control of the PA high voltage plate supply.
2	CONTROL Circuit Breaker	Provides overload protection and primary power control of all transmitter power supplies except for the PA plate and PA screen supplies.

TABLE 3-2. FM-10A PA/DRIVER CABINET CONTROLS AND INDICATORS
(Sheet 1 of 4)

INDEX NO.	NOMENCLATURE	FUNCTION
1	INTERLOCK STATUS Indicator	Indicates all transmitter interlocks are closed when illuminated (external interlock circuit not included).
2	BLOWER STATUS Indicator	Indicates proper operation of the blower when illuminated.
3	FILAMENT STATUS Indicator	Indicates primary ac power is applied to the PA filament transformer when illuminated.
4	HIGH VOLTAGE STATUS Indicator	Indicates the plate power supply is operational when illuminated.
5	VSWR OVERLOAD Indicator	Indicates a PA stage VSWR overload has occurred when illuminated.
6	PLATE OVERLOAD Indicator	Indicates a PA plate circuit overload has occurred when illuminated.
7	SCREEN OVERLOAD Indicator	Indicates a PA screen circuit overload has occurred when illuminated.
8	GRID OVERLOAD Indicator	Indicates a PA grid power supply overload has occurred when illuminated.
9	OVERLOAD RESET Switch/Indicator	SWITCH: Clears the overload circuit memory when depressed. INDICATOR: Indicates an overload condition exists when illuminated.
10	FILAMENT ON Switch/Indicator	SWITCH: Energizes the control contactor when depressed to apply voltage to the exciter, IPA, filament, and grid circuitry INDICATOR: Indicates a filament-on command has been received by the transmitter controller.
11	FILAMENT OFF Switch	Deenergizes all transmitter RF circuit power. The blower and flushing fans will operate for approximately one minute after the FILAMENT OFF switch has been depressed.

TABLE 3-2. FM-10A PA/DRIVER CABINET CONTROLS AND INDICATORS
(Sheet 2 of 4)

INDEX NO.	NOMENCLATURE	FUNCTION
12	HIGH VOLTAGE ON Switch/Indicator	SWITCH: Energizes the step/start contactors when depressed to activate the plate and screen power supplies. INDICATOR: Indicates a high voltage-on command has been received by the transmitter controller.
13	HIGH VOLTAGE OFF Switch	Deenergizes the plate and screen power supplies and mutes RF drive when depressed.
14	AUTOMATIC POWER CONTROL RAISE Switch/Indicator	SWITCH: In the automatic mode, moves the APC reference upward when depressed. In the manual mode, operates the screen control motor in a direction which will raise transmitter RF output power when depressed. INDICATOR: Indicates pulsed screen control motor operation in a direction which will raise transmitter RF power output when illuminated. Extinguishes when a maximum level is obtained.
15	AUTOMATIC POWER CONTROL LOWER Switch/Indicator	SWITCH: In the automatic mode, moves the APC reference downward when depressed. In the manual mode, operates the screen control motor in a direction which will reduce transmitter RF output power when depressed. INDICATOR: Indicates pulsed screen control motor operation in a direction which will lower transmitter RF power output when illuminated. Extinguishes when a minimum level is obtained.
16	AUTOMATIC POWER CONTROL APC ON Switch/Indicator	SWITCH: Selects APC control of transmitter operation. INDICATOR: Indicates the transmitter is under APC control when illuminated.

TABLE 3-2. FM-10A PA/DRIVER CABINET CONTROLS AND INDICATORS
(Sheet 3 of 4)

INDEX NO.	NOMENCLATURE	FUNCTION
17	AUTOMATIC POWER CONTROL PRESET Switch/Indicator	SWITCH: Selects transmitter operation at a preset RF power output level. INDICATOR: Indicates transmitter operation at a preset RF power level (such as half power) has been selected when illuminated.
18	REMOTE DISABLE Switch/Indicator	SWITCH: Inhibits or enables transmitter remote operation. INDICATOR: Indicates remote operation is inhibited when illuminated.
19	OUTPUT POWER METER VSWR CAL Control	Allows calibration of the OUTPUT POWER meter VSWR display.
20	OUTPUT POWER METER FWD/VSWR/ VSWR CAL Switch	Selects the parameter to be displayed by the OUTPUT POWER meter.
21	AM NOISE TEST Receptacle	Test receptacle for AM noise measurements.
22	INTERMEDIATE POWER AMPLIFIER FWD POWER Indicator	Indicates the IPA stage RF output power exceeds 75 Watts when illuminated.
23	INTERMEDIATE POWER AMPLIFIER VSWR Indicator	Indicates the PA stage input circuit VSWR is excessive when illuminated (greater than 10 Watts reflected to the IPA).
24	INTERMEDIATE POWER AMPLIFIER OVER TEMP Indicator	Indicates an IPA stage regulator heat sink over-temperature condition exists when illuminated.
25	BLOWER Circuit Breaker	Provides overload protection and primary power control for the blower, flushing fan, the automatic power control unit, and the transmitter controller.
26	FILAMENT Circuit Breaker	Provides overload protection and primary power control for the PA tube filament supply, the control grid bias supply, and the hum null circuitry.

TABLE 3-2. FM-10A PA/DRIVER CABINET CONTROLS AND INDICATORS
(Sheet 4 of 4)

INDEX NO.	NOMENCLATURE	FUNCTION
27	DRIVER Circuit Breaker	Provides overload protection and primary power control for the FM exciter and intermediate power amplifier.
28	SCREEN Circuit Breaker	Provides overload protection and primary power control for the PA screen grid power supply.
29	FILAMENT TIME Meter	Indicates hours of filament circuit operation.
30	FILAMENT ADJUST Control	Adjusts the PA tube filament voltage.
31	INPUT TUNING Control and Cyclometer	Tunes the PA stage input circuit to resonance.
32	FILAMENT VOLTAGE Meter	Indicates the PA tube filament voltage.
33	GRID CURRENT Meter	Indicates the PA tube control grid current.
34	GRID VOLTAGE Meter	Indicates the PA tube control grid voltage.
35	SCREEN CURRENT Meter	Indicates the PA tube screen grid current.
36	SCREEN VOLTAGE Meter	Indicates the PA tube screen grid voltage.
37	PLATE VOLTAGE Meter	Displays the PA stage plate potential.
38	PLATE CURRENT Meter	Displays the PA stage plate current.
39	OUTPUT POWER Meter	Displays transmitter percentage of RF output power or output VSWR as selected by the OUTPUT POWER METER FWD/VSWR/VSWR CAL switch.
40	OUTPUT LOADING Control and Cyclometer	Adjusts the PA stage output loading.
41	OUTPUT TUNING Control and Cyclometer	Tunes the PA stage output circuit to resonance.

TABLE 3-3. INDICATOR CHECKLIST

INDICATOR	STATUS		
INTERLOCK STATUS	**ON**		OFF
BLOWER STATUS	**ON**		OFF
FILAMENT STATUS	**ON**		OFF
HIGH VOLTAGE STATUS	**ON**		OFF
VSWR OVERLOAD	ON		**OFF**
PLATE OVERLOAD	ON		**OFF**
SCREEN OVERLOAD	ON		**OFF**
GRID OVERLOAD	ON		**OFF**
OVERLOAD RESET SWITCH/INDICATOR	ON		**OFF**
FILAMENT ON SWITCH/INDICATOR	**ON**		OFF
HIGH VOLTAGE ON SWITCH/INDICATOR	**ON**		OFF
REMOTE DISABLE SWITCH/INDICATOR	**ON**	OR	**OFF**
PRESET SWITCH/INDICATOR	ON		**OFF**
APC ON SWITCH/INDICATOR	**ON**		OFF
LOWER SWITCH/INDICATOR	ON		**OFF**
RAISE SWITCH/INDICATOR	ON		**OFF**
IPA FWD POWER	**ON**		OFF
VSWR	ON		**OFF**
OVER TEMP	ON		**OFF**

NOTE

OPERATIONAL STATUS SHOWN BY SHADED INDICATOR

METER	INDICATION	
	POWER	VSWR
OUTPUT POWER	%	:1
PLATE CURRENT	A	
PLATE VOLTAGE	kV	
SCREEN VOLTAGE	V	
SCREEN CURRENT	mA	
GRID VOLTAGE	V	
GRID CURRENT	mA	
FILAMENT VOLTAGE	V	
FILAMENT TIME	HOURS	

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SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section presents the theory of operation for the Broadcast Electronics FM-10A FM transmitter.

4-3. The FM-10A transmitter is divided into functional blocks which are discussed by the following text. The functional blocks consist of the FM exciter, the intermediate power amplifier (IPA), the power amplifier, the automatic power control unit (APC), the transmitter controller, metering circuitry, and the associated power supply circuitry. The power supply and RF circuitry are discussed in further detail at the end of this section. The IPA, APC, and the transmitter controller are described in detail by the modular publications in Part II of this manual. Refer to Figure 4-1 and the overall schematic diagram in SECTION VII as required for the following explanation.

4-4. ELECTRICAL DESCRIPTION.

4-5. FM EXCITER.

4-6. The Broadcast Electronics FX-30 is a totally solid-state wideband FM exciter providing a continuously variable RF output from 3 to 30 watts. The FX-30 operates into a 50 Ohm load at any frequency within the 87.5 to 108 MHz FM broadcast band. The exciter may be programmed to any frequency within the FM band in 10 kHz increments. The FX-30 exciter is mounted on slides to allow easy access to the internal semi-modular exciter circuitry.

4-7. The FX-30 will accept multiple wideband composite inputs from a stereo generator or SCA generator as well as a 600 Ohm balanced audio input. Refer to publication 597-0002 for a detailed explanation of the FX-30 exciter features.

4-8. INTERMEDIATE POWER AMPLIFIER.

4-9. The intermediate power amplifier consists of a broadband solid-state amplifier assembly and a regulated power supply with over-voltage and over-current protection circuitry. Both the amplifier and the regulator are mounted on removable heat sinks built around a fan which provides forced-air cooling.

4-10. The IPA RF stage consists of two bipolar RF power transistors operated in a push-pull Class C configuration. A stripline directional coupler provides forward and reflected power samples. The IPA exhibits a power gain of 10 to output approximately 230 watts to drive the PA stage.

4-11. The IPA is housed in a slide-mounted chassis and equipped with three front-panel status indicators. A green FWD PWR indicator illuminates to indicate a sufficient RF output level for normal operation. A yellow VSWR indicator illuminates to indicate an excessive reflected power condition. A red OVER TEMP indicator illuminates to indicate that an over-temperature condition exists within the module. Refer to the IPA section in Part II of this manual for a more detailed description.

4-12. POWER AMPLIFIER.

4-13. The FM-10A operates from a single 4CX7500A tetrode to provide 10 kW of RF power on a single frequency within the FM broadcast band of 87.5 MHz to 108 MHz. The power amplifier operates in a high-gain, grid-driven class C configuration. A simplified input circuit matches the 50 Ohm output of the IPA to the higher grid input impedance. Use of a large coaxial cavity results in high PA efficiency for comparatively low power consumption. Removal of the PA tube is simple and quick due to the cavity design. A blower cooling system forces air through the tube socket, anode fins, and out through the main transmission line chimney. A differential air pressure sensor monitors the effectiveness of the cooling system and removes power to the tube if air flow is interrupted.

4-14. POWER AMPLIFIER CAVITY. The FM-10A PA stage employs a patented folded half-wave cavity constructed with coaxial aluminum and copper tubing. The cavity design eliminates the high voltage blocking capacitors and high current sliding contacts of conventional cavities through a unique output tuning and coupling technique. A grounded concentric center conductor tunes the cavity by varying the length inserted into the open end of a main high voltage conductor. The main conductor is insulated from ground and carries the full anode dc potential. DC power is fed at the RF voltage null point, approximately one-quarter wave from the tube anode for effective RF decoupling. An untuned loop is used to couple the RF energy into the transmission line.

4-15. OUTPUT COUPLING. Energy is coupled into the transmission line by an adjustable untuned loop which functions in the electromagnetic field within the cavity. One end of the output loop is connected to ground, while the other connects to the center conductor of the output transmission line through flexible straps.

4-16. OUTPUT TUNING. Output tuning is accomplished by adjusting a threaded rod which mechanically expands or contracts a beryllium copper bellows on the end of the grounded center conductor inserted into the main conductor line. Coarse frequency adjustment is accomplished by pre-setting the length of the center conductor into the cavity.

4-17. NEUTRALIZATION. Neutralization is accomplished in the FM-10A by an adjustable distributed inductance which develops a counteractive voltage swing between the screen and the cathode. This cancels out the voltage fed through the internal capacitances of the tube and the stray capacitances of the tube socket. This form of self-neutralization results in very stable operation, and requires no adjustment when the power tube is replaced.

4-18. SECOND HARMONIC SUPPRESSOR. A patented second harmonic suppressor is incorporated into the FM-10A PA cavity design. This consists of a capacitive disc and a lossy series inductance to ground coupled to the main line at the fundamental frequency RF voltage null point. Here, the second harmonic exhibits a high impedance and the suppressor forces its standing wave to diminish, reducing the amplitude of the second harmonic. This unique method of harmonic suppression has minimal effect on the fundamental frequency and does not add losses to the PA cavity at the fundamental frequency.

4-19. OUTPUT CIRCUIT. A low-pass filter is provided with the FM-10A to attenuate all residual second and higher order harmonics. This filter functions over the entire FM broadcast band. Two RF directional couplers are mounted after the filter in the output transmission line connection. The couplers provide filtered forward and reflected power RF samples to the automatic power control unit. A third coupler provides a forward power sample for external test equipment.

4-20. AUTOMATIC POWER CONTROL.

4-21. The automatic power control unit (APC) monitors several transmitter parameters and allows manual or automatic power output control, allows switch selected operation at a preset lower power level, and provides VSWR foldback protection and soft-start features.

4-22. AUTOMATIC RF OUTPUT LEVEL CONTROL. Part of the APC circuitry rectifies PA forward power and reflected power samples. The samples are routed to the power meter selector switch and to the transmitter controller. The APC also monitors screen current and IPA forward power and adjusts the PA screen voltage via a dc servo motor-driven variable autotransformer to maintain a constant transmitter RF output. If excessive PA reflected power, excessive screen current, or low IPA power is measured, the "raise power" command will be in-hibited to prevent an overload from occurring. Manual screen control is assumed by switching the APC off. In the manual mode the raise and lower switches directly control the dc servo motor to vary the screen voltage supply. In the automatic mode, the switches control a reference voltage stored as an eight-bit binary word in a digital memory. This digital memory is maintained by a nine-volt battery so that the transmitter can automatically return to the desired power level whenever power is applied.

4-23. The dc servo motor control circuit uses a pulsed duty-cycle modulation scheme to vary the motor speed. When large excursions of screen voltage are required, a greater duty cycle drives the motor. Fine adjustment of screen voltage utilizes a shorter pulse duty-cycle and therefore a slower motor speed. This feature, combined with an analog deadband in the circuitry, eliminates hunting in this servo loop. The front panel RAISE and LOWER push switches are illuminated by the actual motor drive voltage. The indicator illumination intensity and rate indicates the actual servo system drive.

4-24. VSWR FOLDBACK PROTECTION. PA forward power is automatically reduced if output reflected power becomes excessive enough to overload the transmitter. As the condition which caused the high VSWR returns to normal, RF power will be proportionately raised until full power is again restored.

4-25. SOFT START. A comparator circuit monitors PA plate voltage and reduces the screen voltage to zero upon its absence. When the plate supply is energized, as during initial turn on, the circuit will gradually increase the screen voltage until the stored power setting is achieved. This circuit prevents inadvertent VSWR overloads at turn on, such as during icing of an antenna.

4-26. TRANSMITTER CONTROLLER.

4-27. Transmitter control operations and parameter monitoring is performed by a built-in solid-state controller. The controller incorporates extensive use of RFI filtering and optical isolation in conjunction with CMOS logic to assure maximum reliability.

4-28. Adjustable timers on the primary controller circuit board determine filament warm-up time, blower run-down time, overload-recycle time, and AC restart. The plate, screen, grid, and VSWR overload limits can also be adjusted by potentiometers on the controller circuit board. The range of all controls is limited, however so that the safe operating limits of the transmitter cannot be exceeded by incorrect adjustment.

4-29. The POWER indicator on the controller circuit board illuminates to indicate power is applied to the circuit. The BATTERY TEST indicator indicates the status of the battery backed-up memory supply. When the transmitter is operating on ac power and the BATTERY TEST switch is depressed, illumination of the BATTERY TEST indicator indicates the battery is capable of maintaining the transmitter control memory for more than eight hours.

4-30. MOMENTARY POWER INTERRUPTION. In the event of a momentary power interruption, proper transmitter operation will resume immediately after power returns. If an extended power failure occurs, information maintained by the nine-volt battery will enable the controller to initiate a start cycle to automatically return the transmitter to operation without assistance. If the transmitter safety interlock string opens during a power failure, the automatic restart feature will be defeated and the transmitter will enter the off condition when power is reapplied.

4-31. OVERLOADS. If an overload occurs, the transmitter will deenergize, allow the overload to clear, then automatically return to operation. If four overloads occur within 60 seconds, the transmitter will deenergize. The overload must be manually cleared and the transmitter HIGH VOLTAGE ON switch/indicator depressed before operation will resume. Single overloads of greater than 220 milliseconds duration will immediately deenergize the high voltage and filament supplies.

4-32. INDICATORS. Eight LEDs and three switch/indicators are provided on the front panel as status and overload indicators. The first overload that occurs will be latched into the controller and will illuminate the appropriate red VSWR, PLATE, SCREEN, or GRID LED and the yellow overload reset switch/indicator. All further overloads are monitored by the controller but will not be displayed by the LEDs.

4-33. The green STATUS indicators illuminate to indicate an operational condition as follows: 1) the INTERLOCK LED indicates that the safety interlock loop is closed, 2) the BLOWER LED indicates that the air pressure is correct for the PA stage to operate, 3) the FILAMENT LED indicates primary ac power is applied to the filament transformer, and 4) the HIGH VOLTAGE LED indicates primary ac power is applied to the high voltage plate supply.

4-34. METERING.

4-35. Nine front panel meters indicate transmitter parameters. An iron-vane voltmeter is used to measure filament voltage. Currents are measured on the ground side of each supply to prevent high voltages across the meters. A FILAMENT TIME meter indicates hours of filament circuit operation.

4-36. Additionally, the exciter parameters are displayed by two meters and three status indicators (refer to publication 597-0002).

4-37. OPTIONAL THREE-PHASE AC VOLTMETER. A three-phase ac voltmeter option provides accurate monitoring of the primary ac input voltages. The option consists of an ac voltmeter and an overload-protected three-position switch. The meter and switch are located on the lower front-panel for easy operator access.

4-38. POWER SUPPLIES.

4-39. A three-phase ac input of 197 to 251 volts or 341 to 435 volts is required to operate the transmitter internal power supplies. The plate power supply requires a three-phase ac input with the remainder of the power supplies requiring conventional 220V single-phase circuits obtained from two phases of the three-phase input. Power to the plate supply is applied in two steps to reduce the in-rush current at power-on to limit stress and extend component life in the plate supply.

4-40. The control grid bias and screen power supplies consist of conventional full-wave rectification circuits with input filter sections. A hum-null circuit consisting of a fused transformer and potentiometer assembly injects a small 60 Hz ac voltage in series with the ground return of the grid bias supply to cancel residual ripple from the tetrode amplifier.

4-41. The plate supply is a three-phase primary, six-phase secondary supply. The primary circuit is connected in a closed delta arrangement and the secondary is connected in a wye configuration. Advantages of this type of supply is good regulation and low percentage of ripple output which requires little filtering.

4-42. The filament supply consists of a variable transformer assembly which is used to adjust a high-current low-voltage transformer. A filament voltage regulator option provides a stable input voltage environment for the supply. The device will regulate a wide range of ac input potentials into a stable 240 ±3% volt output.

4-43. Each modular component of the transmitter is equipped with a self-contained ac power supply. In addition, battery back-up supplies in the transmitter controller and automatic power control maintain operational information during power outages. The battery in the APC can remain connected at all times. However, the controller battery will discharge if connected during periods of extended power outages. Both batteries are common nine-volt alkaline types.

4-44. DETAILED DESCRIPTION.

4-45. POWER SUPPLIES.

4-46. The FM-10A requires a three-phase power source of 197V to 251V ac 50/60 Hz or 341V to 435V ac 50 Hz at 100 amperes per phase. The following list presents approximate operating voltage and currents of the transmitter for the rated RF power output.

	PARAMETER	APPROXIMATE VALUES
A.	PA PLATE	+6500V at 2.0 Amperes
B.	PA SCREEN GRID	+800V at 0.070 Amperes
C.	PA CONTROL GRID	-200V at 0.040 Amperes
D.	PA FILAMENT	7V ac at 110 Amperes
E.	HUM NULL	7V ac at 0.15 Amperes

4-47. SEQUENCE OF OPERATION.

4-48. When the transmitter fused disconnect is closed, three-phase ac power is distributed to the CONTROL (CB6) and HIGH VOLTAGE (CB1) circuit breakers. Closing the circuit breakers routes ac power to the following circuitry:

CIRCUIT BREAKER	CIRCUITRY
HIGH VOLTAGE	Power amplifier plate and screen supplies.
CONTROL	Transmitter blower circuit and an ac control circuit (filament supply, control grid bias supply, exciter, IPA, and optional stereo and SCA generators).

4-49. AC power is routed to the controller and the APC unit when the BLOWER circuit breaker (CB2) is closed. A start sequence is initiated when the FILAMENT ON switch/indicator is depressed. Logic from the controller will enable blower driver K1. K1 will apply single-phase power to blower B1, flushing fan B2, and fail-safe solenoid assembly L5. After the blower begins operation, the air switch interlock will close. With the air interlock and all transmitter safety interlocks closed, logic from the controller will enable control contactor driver K2. K2 will energize control contactor K3 which applies ac power to the filament supply, hum null assembly, control grid bias supply, and to a driver ac control circuit. With the DRIVER circuit breaker closed, power is applied to the exciter, IPA, and optional SCA and stereo generators.

4-50. Assuming the HIGH VOLTAGE ON switch/indicator has been depressed, and the PA filament heating delay of at least ten seconds has expired, logic from the controller will enable step/start contactor drivers K5 and K6. K6 will energize step contactor K7 which limits plate supply current in-rush through resistors R1, R2, and R3. K5 will energize start contactor K4 to apply full input potential to the plate and screen power supplies.

4-51. If during a start sequence a safety interlock opens, the entire start sequence will be cancelled and must be re-initiated manually. If a safety interlock opens during operation, the entire power supply section will deenergize. If the interlock is promptly closed, the blower and flushing fans will resume operation to cool the PA tube. To continue transmitter operation, a new manually initiated start sequence is required. Whenever power is removed from the blower and flushing fans, the fail-safe solenoid assembly will short the plate supply to ground.

4-52. If the HIGH VOLTAGE OFF switch/indicator is depressed, the plate and screen power supplies will deenergize. If the FILAMENT OFF switch/indicator is depressed, all remaining power supplies will deenergize. The blower and flushing fan will continue operation for 30 seconds or more to cool the PA tube, then deenergize.

4-53. PA PLATE POWER SUPPLY.

4-54. Three-phase ac power for the PA plate supply is applied to transformer T3. T3 is a three-phase primary, six phase secondary transformer. The primary winding is connected in a closed delta arrangement and protected by circuit breaker CB1. The secondary winding is connected in a wye configuration. Component stress at power on is eliminated by a step/start circuit which limits supply in-rush current.

4-55. Full-wave rectification is accomplished through high-voltage precision diodes D5 through D10. Filtering for the supply is accomplished by a one-section choke-input filter (L2). The choke is inserted in the negative leg of the supply to eliminate the dc potential between the choke and ground. The negative leg of the supply is referenced to ground through the PA stage current meter shunt. Shunt capacitors C5 and C18 bypass residual ac ripple at frequencies above 360 Hz to ground. Bleeder resistors R12, R13, and R14 increase regulation and in conjunction with the fail-safe solenoid assembly, enhance safety. A series resistance in the anode dc feedline limits peak energy in the event of arc-overs in the power amplifier stage. A one-half voltage supply tap is provided for transmitter troubleshooting.

4-56. Component stress at power-on is eliminated by a step/start circuit which limits plate supply in-rush current. The step/start circuit is interlocked through contacts of the filament circuit breaker and the control contactor to assure that the filament circuit is energized before a high-voltage-on sequence can be initiated. A high-voltage-on sequence begins when the controller energizes step contactor K7 via driver K6. After 100 milliseconds, the controller will energize start contactor K4 via driver K5. Next, the step contactor will deenergize after it has been energized for 160 milliseconds. In this manner, the current limiting resistors will only be subject to heating during a 100 millisecond interval between the step and start contactor closures.

4-57. PA SCREEN POWER SUPPLY. The screen power supply is a full-wave bridge-rectified supply with a two-stage L-section filter. Overload protection for the circuit is provided by circuit breaker CB3. The primary of screen transformer T2 is connected to a variable autotransformer (T1) which is used to adjust the screen supply output. A dc motor connected to the variable autotransformer allows both manual and automatic control of the screen voltage. Capacitors C6 and C17 provide additional power supply filtering. Bleeder resistor R8 improves regulation and enhances safety.

4-58. PA CONTROL GRID BIAS POWER SUPPLY. The control grid bias supply is a full-wave bridge-rectified supply with a single C-section filter. Overload protection for the supply is provided by circuit breaker CB5. Resistors R7 and R9 operate to determine the cut-off point of the supply. Diode D8 isolates the tube grid from the bias supply to improve immunity to AM noise. Bleeder resistor R6 improves regulation and enhances safety. Resistor R16 allows voltage adjustment of the supply.

4-59. Hum Null Supply. The ground path of the grid bias supply is routed through a hum-null circuit which introduces a small 60 Hz ac component into the supply to cancel hum in the PA tube from the screen supply. The amplitude of the 60 Hz signal is adjusted by potentiometer R10. The hum null voltage is out-of-phase with the 60 Hz ripple component of the screen supply.

4-60. PA FILAMENT SUPPLY. The PA filament supply is a low-voltage high current ac supply. Overload protection for the circuit is provided by circuit breaker CB5. An optional filament voltage regulator provides a stable ac input voltage environment. Primary power transformation is provided by transformer T5. Variable inductor L3 provides accurate filament voltage adjustment. A FILAMENT TIME meter indicates hours of filament circuit operation. A fusible link in the center-tap of the filament transformer secondary provides overload protection for the filament supply wiring if a short-circuit to ground develops in either leg of the filament supply.

4-61. RF CIRCUITRY.

4-62. FM EXCITER. The modulated FM signal for RF circuit operation is generated by the FX-30 FM exciter (see Figure 4-3). Approximately 25 watts of drive is required to operate the FM-10A PA circuitry. Refer to publication 597-0002 for a complete description of the FM exciter.

4-63. INTERMEDIATE POWER AMPLIFIER. The IPA provides an approximate gain of 10 to output approximately 230 watts of power to drive the FM-10A PA stage. The unit is totally self-contained with an internal power supply, regulator, and RF amplifier. The amplifier is configured as a Class C push-pull stage. For a complete description of the IPA module, refer to Part II of this manual.

4-64. POWER AMPLIFIER. The FM-10A PA stage contains a single 4CX7500A tetrode operated as a Class C amplifier in a folded half-wave cavity to output 10 kW of RF power. The amplifier operates in a grid driven configuration and exhibits high efficiency and ease of maintenance. The following text describes the operation of components and circuits within the PA stage.

4-65. PA Input Circuit. The grid impedance-matching circuit used in the FM-10A transmitter consists of a combination of series inductor and shunt capacitor elements, implemented on a printed circuit board. The inductors and capacitors are etched into the copper-clad laminate. Multiple LC sections match the 50 Ohm source impedance to the higher input impedance of the PA tube.

4-66. This input matching design provides wide bandwidth and improves reliability, stability, and maintainability of the transmitter. A single tuning/loading control in the input circuit is provided to adjust and match the 50 Ohm driver impedance to the higher input impedance of the grid over the 88 to 108 MHz FM broadcast band.

4-67. The grid circuit is adjusted for proper operation with two paralleled "hairpin-shaped" inductors which connect to ground. The controls employ sliding shorts to tune the grid capacitance to resonance. One inductor is mechanically connected to the front panel input tuning control while the other inductor is connected to a counter in the rear of the RF enclosure. Fine tuning is accomplished by adjusting either one of the inductors (normally the front panel control). A resistive loading component is included in the circuit to broaden the overall response.

4-68. The screen ring is connected through four fixed inductors (L7, L8, L10, and L11) to four copper-clad Kapton bypass capacitors (C7, C8, C16, and C17) to ground. The bypass capacitors short any ac components to ground and aid in neutralization. Neutralization is accomplished by adjusting the length of an internal inductor (L15) which is connected to a capacitive plate (C18) at the tube anode. This neutralization circuit introduces an out-of-phase current component causing a voltage swing across the screen to cathode which cancels internal ac feed-thru components. Two spark-gaps are provided to safely conduct energy if the tube should arc internally.

4-69. Power Amplifier Cavity. The PA cavity used in the FM-10A employs a folded half-wave resonator constructed with coaxial aluminum and copper tubing (see Figure 4-4). The design eliminates the high voltage blocking capacitors and high current shorting contacts of conventional cavities. A grounded concentric center conductor tunes the cavity with a variable re-entrant length inserted into the end of a main high voltage conductor. The main conductor is insulated from ground and carries the full anode dc potential. DC power is fed at the RF voltage null point, approximately one-quarter wave from the anode, for effective RF decoupling. An untuned loop operating in the electromagnetic field is used to couple the RF energy into the transmission line. Rather than attenuating second harmonic after the signal has been generated and amplified, the circuitry within the cavity essentially eliminates formation of the second harmonic component.

4-70. Plate tuning is accomplished by an adjustable bellows on the center portion of the plate line which is maintained at chassis ground potential. The PA plate potential is applied to the main conductor (the fixed portion of the plate line) at the fundamental frequency RF voltage null point. Second harmonic suppression is accomplished by a series LC circuit consisting of L6 and C9 which is inserted at the peak voltage point to essentially eliminate the second harmonic component.

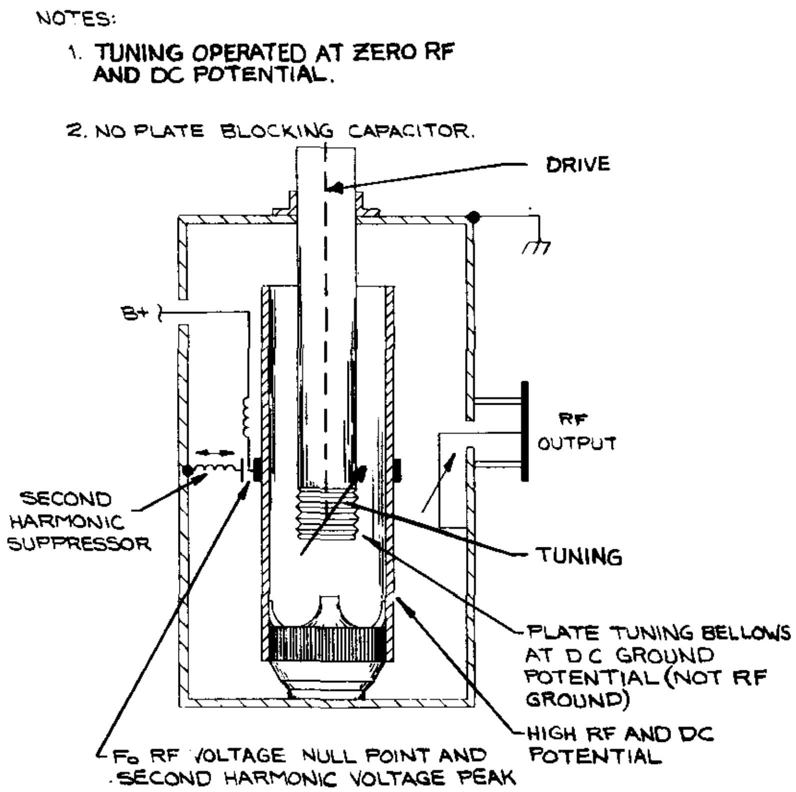

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FIGURE 4-4. PA CAVITY

4-71. PA Output Circuit. Output coupling is accomplished with an untuned loop intercepting the magnetic field concentration at the voltage null point of the main line. The PA loading control varies the angular position of the plane of the loop with respect to the plate line, changing the amount of magnetic field which it intercepts. Multiple phosphor bronze leaves connect one side of the output loop to ground and the other side to the center conductor of the output transmission line. This allows for mechanical movement of the loop by the PA loading control without utilizing any sliding contacts. The grounded loop improves immunity to lightning and static buildup on the antenna connection.

4-72. A pair of directional couplers located in the output transmission line provide RF output voltages proportional to the PA forward and reflected power. The RF output voltages provide power and VSWR samples for the output power meter, the transmitter controller, and inputs to the automatic power control unit. An additional port in the transmission line provides a point to connect a station modulation monitor.

4-73. PA METERING. Eight meters are used to indicate transmitter power tube parameters. An iron vane filament voltmeter is included to accurately measure filament voltage at the cavity feedthrough terminals. Six of the meters measure samples derived from the PA metering circuit board. Additional samples from this circuit board are routed to the controller for overload and diagnostic features. Fuses mounted on the circuit board are used to protect the filament meter wiring. Plate voltage metering is obtained from a high voltage meter multiplier circuit board. Power output metering is derived from circuitry within the automatic power control unit. A FILAMENT TIME meter indicates total elapsed time of filament circuit operation.

4-74. AUTOMATIC POWER CONTROL. The automatic power control unit (APC) monitors a number of transmitter parameters to function as part of a closed loop which maintains a constant RF output level from the transmitter (see Figure 4-3).

4-75. PA forward and reflected power samples from the transmitter low-pass filter are applied to individual rectifier/amplifier circuits in the APC unit. The outputs from the rectifier/amplifier circuits are routed to the output power meter to provide indications of transmitter operation. The amplified power samples are also applied to automatic forward and reflected power control circuits. Raise/lower power control logic monitors several parameters such as the forward and reflected power control circuits, screen current, and IPA forward power to determine if power control and correction is required. The output of the raise/lower logic is used to control the adjustable screen supply autotransformer when automatic power control is enabled.

4-76. When the automatic power control circuitry is enabled and as RF output power varies, the forward automatic power control circuit will act to maintain the established RF output level. If inadequate IPA drive exists for normal operation or if PA reflected power increases (or if screen current is high), any power increase will be inhibited. If the PA reflected power increases to a point which may damage the RF circuitry of the transmitter, the circuit will reduce the RF output to a safe level and the transmitter will continue to operate. Full power will be automatically re-established when the VSWR condition is corrected.

4-77. As an additional function, a plate voltage comparator reduces the PA screen potential to minimum whenever the plate voltage if off. Whenever the plate voltage is energized, the circuit will gradually increase the PA screen voltage until the rated transmitter RF output is established unless limited by low IPA drive, a high VSWR condition or high screen current.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides general maintenance information, electrical adjustment procedures, and troubleshooting information for the Broadcast Electronics FM-10A transmitter.

5-3. SAFETY CONSIDERATIONS.

WARNING

WARNING

WARNING

NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.

5-4. The FM-10A transmitter contains high voltages and currents which, if regarded carelessly, could be fatal. The transmitter has many built-in safety features, however good judgement, care, and common sense are the best accident preventives. The maintenance information contained in this section should be performed only by trained and experienced maintenance personnel.

5-5. It is extremely dangerous to attempt to make measurements or replace components with power energized, therefore such actions must not be performed. The design of the equipment provides safety features such that when a door is opened or an access panel is removed, interlock switches will deenergize all dc power supplies and release the fail-safe discharge solenoid across the plate supply. Do not bypass the interlock switches as a maintenance short-cut.

5-6. The PA cavity access door actuates an interlock switch if the door is opened during transmitter operation. All dc supplies will be deenergized and the plate supply will be shorted to ground.

5-7. Two grounding sticks are provided as a safety features. Each grounding stick consists of a metal hook with a phenolic handle. The metal end is connected to chassis ground. Use the grounding stick to touch every part in the area or circuit on which maintenance is to be performed before attempting maintenance.

5-8. Each grounding stick rests on a hook switch. When the grounding stick is removed, the associated hook switch will open the transmitter safety interlock string and deenergize all transmitter dc potentials until the grounding stick is replaced.

5-9. FIRST LEVEL MAINTENANCE.

WARNING WARNING WARNING WARNING

DUE TO THE PROGRAMMING OF THE EQUIPMENT, THE APC UNIT WILL ENTER THE REMOTE ENABLED MODE WHENEVER AC POWER IS APPLIED. TO PREVENT INADVERTENT REMOTE START-UP DURING MAINTENANCE PERIODS, DISCONNECT POWER FROM THE TRANSMITTER AND INSTALL JUMPER P14 ON THE APC UNIT MAIN CIRCUIT BOARD IN POSITION 1-2.

5-10. First level maintenance consists of procedures applied to the equipment to prevent future failures. The procedures are performed on a regular basis and the results recorded in a maintenance log. Preventive maintenance of the FM-10A transmitter consists of good housekeeping, lubrication, and checking performance levels using the meters and various indicators built into the equipment.

5-11. MISCELLANEOUS.

WARNING WARNING WARNING

NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.

5-12. On a regular basis, clean the equipment of accumulated dust. Check for overheated components, tighten loose hardware, and lubricate mechanical surfaces as required. A lubricant such as "Lubriplate" should be applied sparingly to the tuning drives, cables, the PA tuning line right angle gear mechanism, and the cyclometer drives behind the front panel. The PA output loading screw drive should be opened (four screws) and lubricated every 36 months, or more often if resistance is noted.

5-13. Periodically, the transmitter controller battery should be checked by depressing the controller battery test switch. If the green battery test indicator fails to illuminate, the battery should be replaced. A good-quality alkaline battery is recommended for replacement. Typically, it is a good practice to replace the transmitter controller and automatic power control unit battery annually, regardless of the battery condition.

5-14. AIR FILTER.

5-15. Air filter replacement is accomplished from outside the transmitter without interrupting equipment operation. The filter should be checked once each week with replacement done on an as-required basis. A dirty filter could result in dust accumulation leaking into the cabinet from seams, door jambs, etc. Never reverse a dirty filter. Always replace the filter. The transmitter controller and APC unit also contain air filters which should be checked monthly and cleaned as necessary.

5-16. The transmitter uses one disposable type air filter 1 inch X 16 inches X 20 inches (2.54 cm X 40.64 cm X 50.8 cm). Additional filters may be ordered for replacement (P/N 407-0062) or purchased locally. Always install the filter with the airflow arrow pointing towards the blower.

5-17. BLOWER MAINTENANCE.

<u>WARNING</u>
<u>WARNING</u>
<u>WARNING</u>

NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.

5-18. Inspect the blower and the flushing fan for dust accumulation and periodically clean the blower and fan using a brush and vacuum cleaner. The blower and fan motors are cooled by air passing around each motor. If the ambient air temperature is too high or if the air flow is restricted, the lubricant will gradually vaporize from the motor bearings and bearing failure will occur. If dirty air passes over the motors, accumulated dust will impair motor cooling unless the accumulation is wiped from and blown out of the motor.

5-19. The blower and fan impeller blades should be inspected and cleaned periodically. If the transmitter is operated in a very dusty environment, dust will build up on the concave side of the blower and fan impellers. If this happens, air flow will be reduced and unbalance will result with a possibility of damage to the blower or fans.

5-20. The blower motor and the flushing fan are equipped with sealed element-type bearings which do not permit lubrication. Therefore, no regular motor lubrication maintenance is required. However, check the blower and flushing fan mounting hardware at regular intervals to ensure proper operation.

5-21. SECOND LEVEL MAINTENANCE.

WARNING
WARNING
WARNING
WARNING

DUE TO THE PROGRAMMING OF THE EQUIPMENT, THE APC UNIT WILL ENTER THE REMOTE ENABLED MODE WHENEVER AC POWER IS APPLIED. TO PREVENT INADVERTENT REMOTE START-UP DURING MAINTENANCE PERIODS, DISCONNECT POWER FROM THE TRANSMITTER AND INSTALL JUMPER P14 ON THE APC UNIT MAIN CIRCUIT BOARD IN POSITION 1-2.

5-22. Second level maintenance consists of procedures required to restore the transmitter to operation after a fault has occurred.

5-23. The maintenance philosophy of the FM-10A transmitter consists of problem isolation to a specific area. Subsequent troubleshooting provided by each applicable assembly of this manual will assist isolation to a specific assembly or component. If desired, a defective assembly may be returned to the factory for repair or exchange.

5-24. GENERAL.

5-25. PA STAGE. Power amplifier tube life is a result of several circuit parameters. Usually, the first indication of the decline of a tube is a slight reduction in power output. This can normally be corrected by a small increase in filament voltage. It may be wise to order a new tube at this time. Further reductions in power output can be compensated in the same manner only a limited number of times. An Eimac application paper titled "Extending Transmitter Tube Life" is provided in APPENDIX A of this manual. Excess control grid or screen grid dissipation will shorten the life of a tube. Also, excess plate dissipation always indicates trouble. Typical FM-10A PA efficiency is plotted in Figure 5-1 and should be referenced to estimate PA efficiency for a particular power level.

5-26. PA Tube Warranty. The FM-10A transmitter PA tube is covered by warranty from the Varian/Eimac Company, the tube manufacturer, not Broadcast Electronics, Inc. However, a tube purchased from Broadcast Electronics which is defective must be returned to Broadcast Electronics with a customer-completed warranty claim service report. A warranty claim service report form is shipped with each tube obtained from Broadcast Electronics, Inc. Following this procedure, Broadcast Electronics will expedite immediate shipment of a new tube. Contact the Broadcast Electronics, Inc. Customer Service Department for additional details as required. It is recommended that the warranty report be completed as soon as the new tube is placed in operation while the nominal voltages are known.

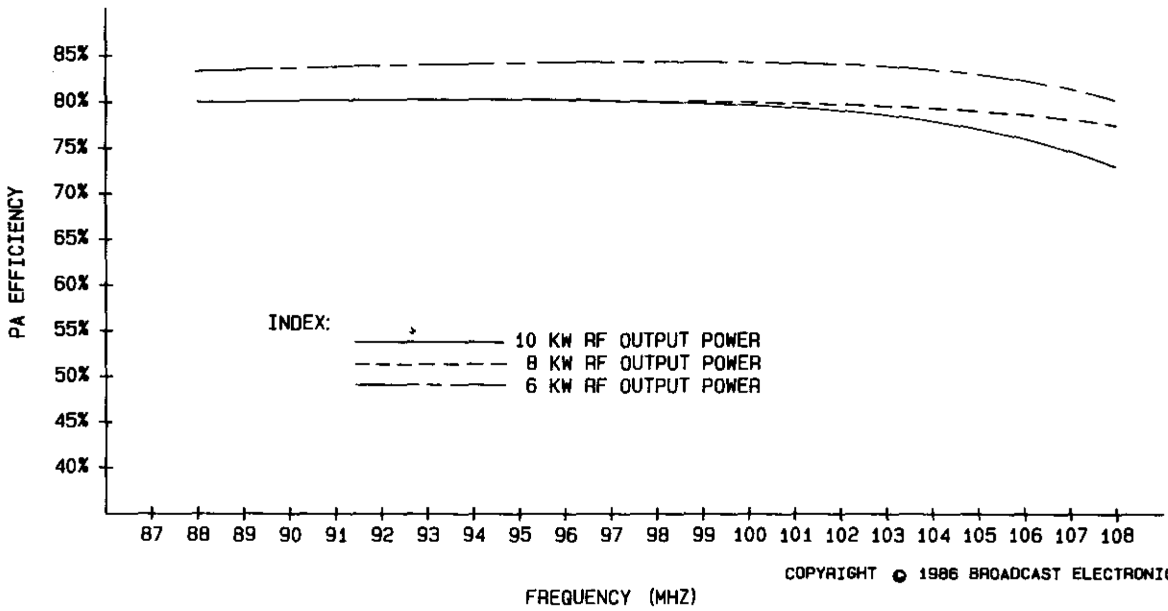

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FIGURE 5-1. FM-10A TYPICAL PA EFFICIENCY

<u>WARNING</u> BERYLLIUM OXIDE CERAMICS (BeO) - AVOID BREATHING DUST OR FUMES.

<u>WARNING</u>
<u>WARNING</u>
<u>WARNING</u>
<u>WARNING</u>
<u>WARNING</u>
<u>WARNING</u>

THE WHITE CASE MATERIAL OF THE FM-10A IPA STAGE RF AMPLIFIER TRANSISTORS IS MADE OF BeO CERAMIC MATERIAL. DO NOT PERFORM ANY OPERATION ON ANY BeO CERAMIC WHICH MIGHT PRODUCE DUST OR FUMES, SUCH AS GRINDING, GRIT BLASTING, OR ACID CLEANING. BERYLLIUM OXIDE DUST OR FUMES ARE HIGHLY TOXIC AND BREATHING THEM CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH. BeO CERAMICS MUST BE DISPOSED OF ONLY IN A MANNER PRESCRIBED BY THE DEVICE MANUFACTURER. USE CARE IN REPLACING TRANSISTORS OF THIS TYPE.

5-27. IPA STAGE. The transistors in the intermediate power amplifier will normally last many times longer than the power amplifier tube unless a major fault occurs such as a regulator malfunction. For further information, refer to the IPA publication in Part II of this manual.

5-28. ADJUSTMENTS.

<u>WARNING</u> NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING ANY MAINTENANCE.

<u>WARNING</u>

<u>WARNING</u>

5-29. Adjustment procedures for controls associated with the IPA, APC unit, and the transmitter controller are presented in each applicable publication in Part II of this manual. Adjustment procedures for the power supply and PA controls are presented as follows:

A. Hum Null Adjustment.

B. Control Grid Bias Level Adjustment.

C. Second Harmonic Suppressor Adjustment.

D. Neutralization.

5-30. HUM NULL ADJUSTMENT. The hum null circuit injects a small 60 Hz ac voltage into the control grid bias supply to cancel ac components and reduce AM noise. Adjustment of the circuit will not normally be required in the field. However, if it is certain that hum null circuit adjustment is required, proceed as follows.

5-31. <u>Required Equipment.</u> The following equipment is required to adjust the hum null circuit.

A. FM modulation monitor (Booton Model 82AD or equivalent).

B. Distortion analyzer (Tektronics Model AA501 or equivalent).

C. Two locally fabricated test cables consisting of the following:

   1. 10 feet (3.05 m) of Belden RG58A/U coaxial cable (BE P/N 622-0050).

   2. Two BNC connectors (Pomona UG68/U - BE P/N 417-0205).

<u>WARNING</u> NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING ANY MAINTENANCE.

<u>WARNING</u>

<u>WARNING</u>

5-32. <u>Procedure.</u> To adjust the hum null circuit, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

5-33. Deenergize all primary power to the transmitter.

5-34. Connect the FM modulation monitor RF input to the transmitter RF sample port on the output transmission line elbow assembly using one of the coaxial test cables (Item C).

5-35. Connect the modulation monitor output to the distortion analyzer input using one of the coaxial test cables (Item C).

5-36. Energize the transmitter primary ac input and operate the transmitter.

5-37. Refer to Figure 5-2 and adjust hum null control R10 for a minimum AM noise indication on the distortion analyzer.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

5-38. Deenergize all primary power to the transmitter.

5-39. Disconnect and remove all test equipment.

5-40. CONTROL GRID BIAS LEVEL ADJUSTMENT. A control in the grid bias circuit allows adjustment of the bias level. Adjustment of the control will not normally be required in the field. If it is certain that adjustment of the grid bias level is required, contact the Broadcast Electronics Customer Service Department for a recommended test procedure and a list of required equipment.

5-41. SECOND HARMONIC SUPPRESSOR. Adjustment of the second harmonic suppressor in the field will not normally be required, even if the PA tube is replaced. Adjustment should be attempted only when absolutely necessary. Misadjustment of the suppressor could result in sporadic operation, possibly damaging the PA tube, the cavity, or the low-pass filter. It is suggested the customer contact the Broadcast Electronics Customer Service Department before attempting this adjustment. If it is certain that adjustment of the second harmonic suppressor is required, proceed as follows.

5-42. Required Equipment. The following equipment is required to adjust the transmitter second harmonic suppressor.

A. 1/16 inch (1.6 mm) hex wrench.

B. Tektronix Model 492 Spectrum Analyzer or equivalent capable of displaying frequencies at twice the transmitter frequency of operation.

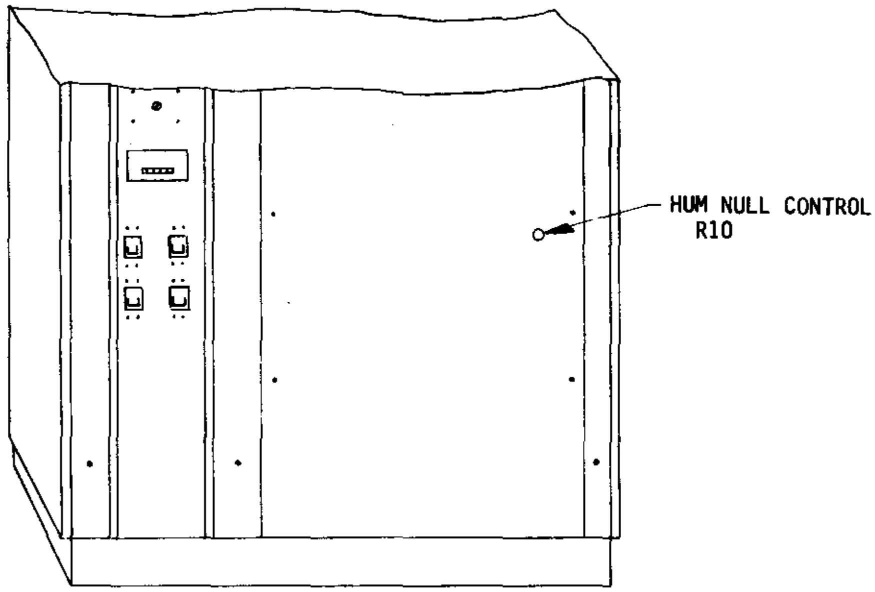

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FIGURE 5-2. HUM NULL CONTROL LOCATION

C. 50 Ohm 10 dB resistive attenuator pad, BNC jack to BNC plug (Texscan FP-50).

D. A test cable for the spectrum analyzer consisting of the following:

   1. 10 feet (3.05 m) of Belden RG58A/U coaxial cable (BE P/N 622-0050).

   2. Two BNC plugs (Pomona UG88/U--BE P/N 417-0205).

E. Six inch scale, graduated in sixty-forths of an inch.

WARNING
WARNING
WARNING

NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING ANY MAINTENANCE.

5-43. Procedure. To adjust the second harmonic suppressor, proceed as follows:

WARNING   DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

5-44. Deenergize all primary power to the transmitter.

5-45. Open the PA/driver cabinet rear door.

5-46. Connect one end of the spectrum analyzer cable (Item D) to the RF sample port on the transmission line elbow.

5-47. Connect the attenuator pad (Item C) in series with the spectrum analyzer cable and attach the attenuator pad to the spectrum analyzer input.

5-48. Close the PA/driver cabinet rear door.

5-49. Energize the transmitter primary ac input.

5-50. Operate the transmitter at the normal power output and ensure all PA stage tuning and loading controls are correctly adjusted.

5-51. Record the level of the second harmonic displayed on the spectrum analyzer ________________.

WARNING   DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

5-52. Disconnect all transmitter primary power.

5-53. Open the PA/driver cabinet rear door.

5-54. Loosen the two hex-head lock-screws securing the second harmonic suppressor adjustment rod very slightly--just enough to allow in and out adjustment (see Figure 5-3).

CAUTION   THE SECOND HARMONIC SUPPRESSOR IS ADJUSTED BY SLIDING THE ADJUSTMENT ROD IN OR OUT. DO NOT ROTATE THE ROD.
CAUTION

NOTE   THE ORIGINAL HARMONIC SUPPRESSOR ADJUSTMENT DIMENSION IS RECORDED ON THE FACTORY FINAL TEST DATA SHEETS IF THE DIMENSION MUST BE REFERENCED.
NOTE

5-55. Move the second harmonic suppressor adjustment rod slightly (approximately 1/16 inch). Record the amount moved and the direction (in or out) ________________. Slightly tighten the two screws to secure the rod in place.

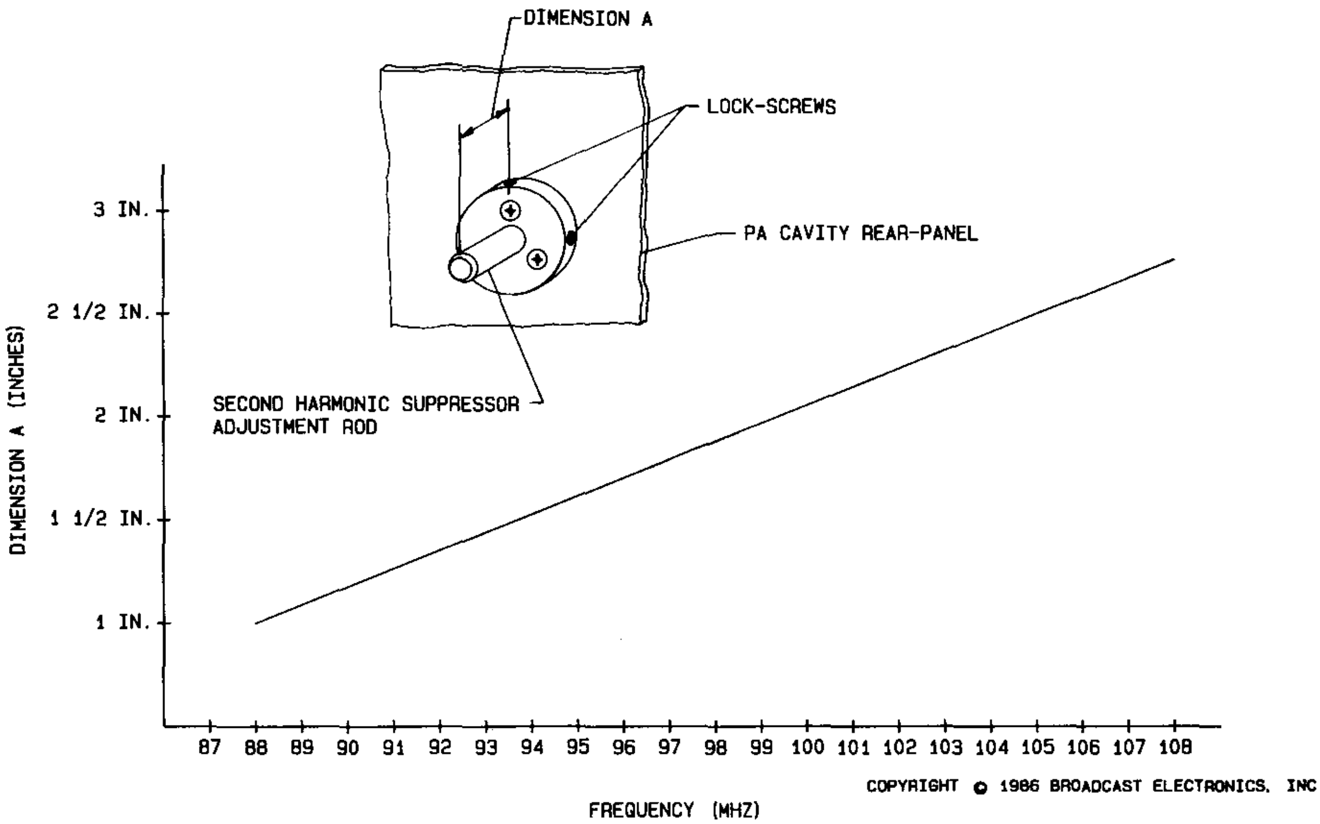

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FIGURE 5-3. SECOND HARMONIC SUPPRESSOR ADJUSTMENT

5-56. Close the PA/driver cabinet rear door.

5-57. Operate the transmitter at the normal power output and check for a minimum second harmonic indication displayed on the spectrum analyzer.

5-58. Repeat paragraphs 5-52 through 5-57, moving the second harmonic suppressor adjustment rod slightly in or out as required to minimize the second harmonic indication.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

5-59. After the correct placement of the second harmonic suppressor is determined, disconnect all transmitter primary power.

5-60. Open the PA/driver cabinet rear door.

5-61. Secure the two hex-head lock-screws on the second harmonic suppressor bushing (see Figure 5-3).

5-62. Disconnect the spectrum analyzer cable from the transmission line.

5-63. Close the PA/driver cabinet rear door. Refer to Figure 5-3 and record the new harmonic suppressor dimension ___________________.

5-64. NEUTRALIZATION. PA neutralization in the field will not normally be required, even if the PA tube is replaced. If it is certain that adjustment of the neutralization circuitry is required, proceed as follows.

CAUTION — INCORRECT NEUTRALIZATION CAN RESULT IN INSTABILITY WHICH COULD DAMAGE THE PA TUBE, CAVITY, OR LOW-PASS FILTER. CONSULT THE FACTORY BEFORE ATTEMPTING PA NEUTRALIZATION. — CAUTION

5-65. Required Equipment. The following equipment is required to complete PA neutralization.

A. Spectrum analyzer (Tektronix Model 492 or equivalent).

B. 25 Watt, 50 Ohm RF attenuator/termination with -20 dB sample output, type N receptacles (Bird Model 8340-030 or equivalent).

C. Two locally fabricated cables, each consisting of the following:

    1. 36 inches (91.44 cm) of Belden RG 58A/U coaxial cable (BE P/N 622-0050).

    2. Two BNC plugs (Pomona UG88/U--BE P/N 417-0205).

D. Three adapters, BNC receptacle to type N plug (Pomona UG201A/U--BE P/N 417-3288).

E. No. 2 Phillips screwdriver, 4-inch (10.2 cm) blade.

F. Flat-tip screwdriver, 4-inch (10.2 cm) blade and 1/4 inch (0.64 cm) tip.

G. Exciter line cord (P/O exciter accessory pack--BE P/N 682-0001).

H. Fuse, AGC, 3A slow-blow, 120V (P/O exciter accessory pack--BE P/N 334-0300).

I. Electrical extension cord, 3-wire, 12 feet (3.7 m) long;

5-66. <u>Procedure</u>. To adjust PA neutralization, proceed as follows:

5-67. Operate the transmitter at the normal power output and ensure all PA stage tuning and loading controls are correctly adjusted.

5-68. Secure the INPUT TUNING, OUTPUT LOADING, and OUTPUT TUNING control knobs in position with tape. The controls must not be moved until the entire procedure has been completed.

<u>WARNING</u> DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

5-69. Deenergize all primary power to the transmitter.

5-70 Open the PA/driver cabinet rear door.

5-71. Disconnect the coaxial cable from the exciter RF OUTPUT connector.

5-72. Connect a BNC-to-type N adapter on each of the RF termination connectors.

5-73. Disconnect the cable from the PA RF INPUT receptacle.

5-74. Connect one cable and one BNC-to-type N adapter between the PA RF INPUT (J1) connector and the RF termination -20 dB output.

5-75. Connect one cable between the exciter RF OUTPUT connector and the input to the RF termination.

5-76. Disconnect wire No. 5 from TB1-7 on the rear of the exciter and connect a temporary wire jumper from TB1-6 to TB1-7. Flag the temporary jumper with a piece of tape marked "TEMPORARY".

5-77. Disconnect the exciter line cord and remove the fuse from the AC LINE VOLTAGE SELECTOR on the rear panel. Cover the line cord plug with a piece of tape marked "240 VOLTS".

5-78. Remove the exciter AC LINE VOLTAGE SELECTOR circuit board with a small pair of needle-nose pliers and record the circuit board voltage indication ____________V___. Reinsert the circuit board so that "115/120V" is visible when the circuit board is inserted into the receptacle.

5-79. Replace the exciter fuse with a slow-blow type rated at 3 Amperes.

5-80. Connect the exciter accessory line cord to the extension cord. Route the extension cord out through the top or bottom of the cabinet to a 110 to 120 volt ac source.

5-81. Connect the accessory exciter line cord to the exciter.

5-82. Connect the spectrum analyzer to the RF sample port in the transmitter output transmission line. Adjust the analyzer to obtain a reference level display and position the analyzer so that it may be viewed from the rear of the transmitter.

WARNING PRIMARY AC POWER MUST REMAIN OFF THROUGHOUT THE FOLLOWING PROCEDURE.

5-83. Assure that the exciter is operating independently of the transmitter.

5-84. Refer to Figure 5-4 and check the NEUT cyclometer indication. Correct neutralization will be found near the original factory set position.

5-85. Adjust PA neutralization by adjusting the NEUT cyclometer for a minimum indication on the spectrum analyzer.

5-86. Record the new NEUT cyclometer indication ________________.

5-87. Disconnect the spectrum analyzer from the transmission line RF sample output.

CAUTION DO NOT CONNECT THE EXCITER TO THE LINE CORD WIRED INTO THE TRANSMITTER IN THE FOLLOWING STEP.

CAUTION

5-88. Remove the electrical extension cord and exciter line cord. Do not connect the exciter to the line cord wired into the transmitter at this time.

5-89. Remove the fuse from the exciter rear panel AC LINE VOLTAGE SELECTOR.

5-90. Remove the AC LINE VOLTAGE SELECTOR circuit board with a small pair of needle-nose pliers. Reinsert the circuit board so that the voltage recorded in paragraph 5-78 is visible when the circuit board is inserted into the receptacle.

5-91. Replace the fuse with a slow-blow type rated at 1.5 Amperes.

5-92. Remove the tape from the exciter line cord and connect the plug to the exciter.

5-93. Remove the temporary wire jumper from TB1 on the exciter rear panel and reconnect wire No. 5 to TB1-7.

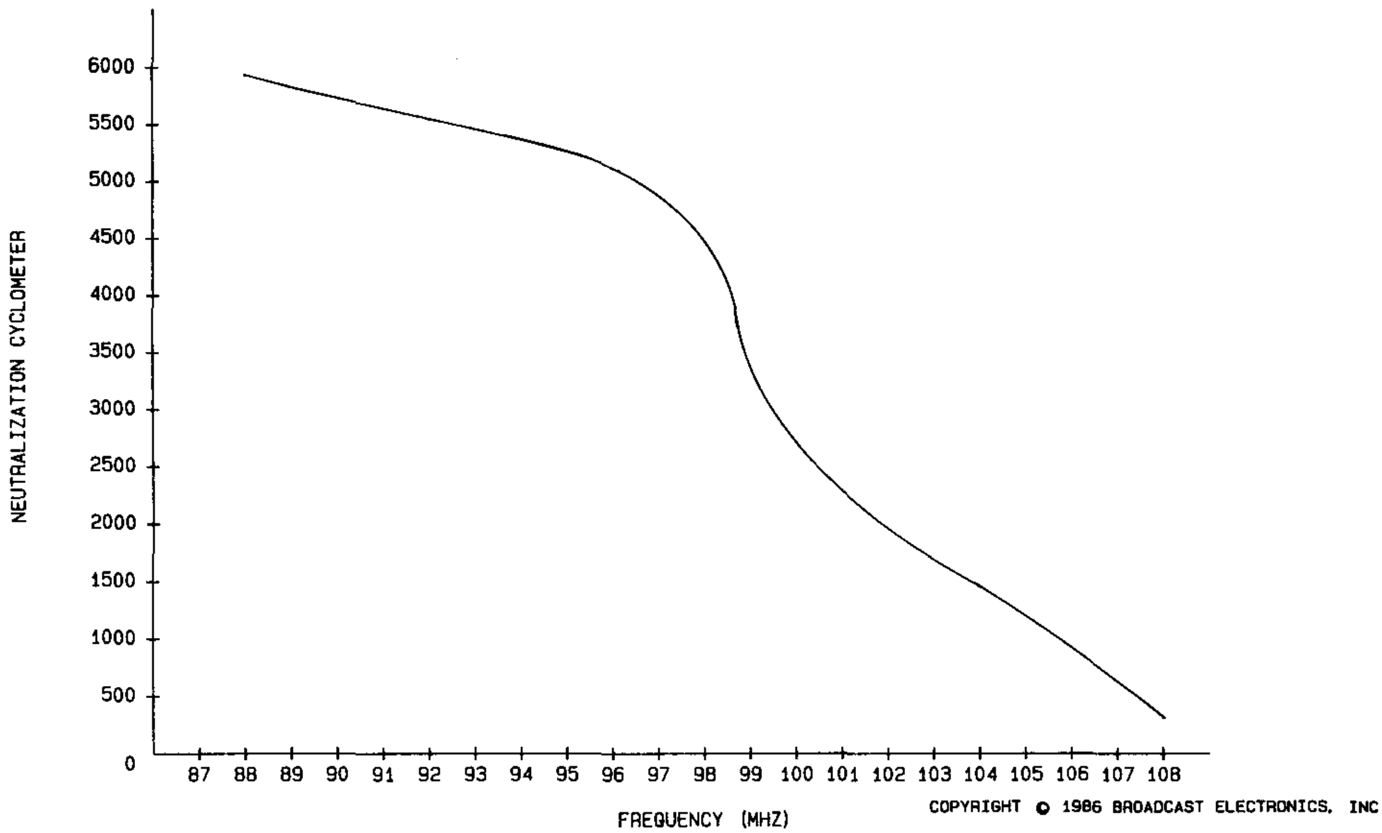

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FIGURE 5-4. PA NEUTRALIZATION

5-94. Remove the cabling and test load connected between the exciter RF OUTPUT connector and the PA RF INPUT connector. Remove the adapter from the PA RF INPUT connector.

5-95. Reconnect the exciter to the IPA input and reconnect the IPA output to the PA input.

5-96. TRANSMITTER FREQUENCY CHANGE PROCEDURE.

CAUTION CONSULT THE FACTORY BEFORE ATTEMPTING TO CHANGE THE TRANSMITTER OPERATING FREQUENCY.

5-97. GENERAL. The following text presents an overall procedure to change the transmitter operating frequency. The procedure specifies operational adjustment procedures located throughout this publication and FX-30 Exciter publication 597-0002. To change the transmitter operating frequency, proceed as follows.

5-98. <u>Procedure.</u> To change the transmitter operating frequency, proceed as follows:

<u>WARNING</u> <u>WARNING</u> <u>WARNING</u>	NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.
<u>WARNING</u>	DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

5-99. Disconnect all transmitter primary power. The primary ac power must remain OFF unless specified by an adjustment procedure.

5-100. Refer to Figure 5-5A and adjust the transmitter coarse output tuning by raising or lowering the PA tuning line on top of the PA cavity. Refer to Figure 5-5B and coarse adjust the transmitter input tuning cyclometers.

5-101. Refer to Figure 5-3 and coarse adjust the transmitter second harmonic suppressor. The suppressor is adjusted by loosening the two hex-head lock screws and moving the adjustment rod in or out as required. Do not rotate the rod during adjustment.

5-102. Refer to Figure 5-4 and coarse adjust the transmitter neutralization cyclometer.

5-103. Refer to FX-30 Exciter publication 597-0002, PART II SECTION 4, AFC/PLL ASSEMBLY and perform the FREQUENCY SELECTION procedure. Operate and test the exciter independently from the transmitter.

5-104. Refer to IPA SECTION II, MAINTENANCE and perform the RF AMPLIFIER TUNING procedure.

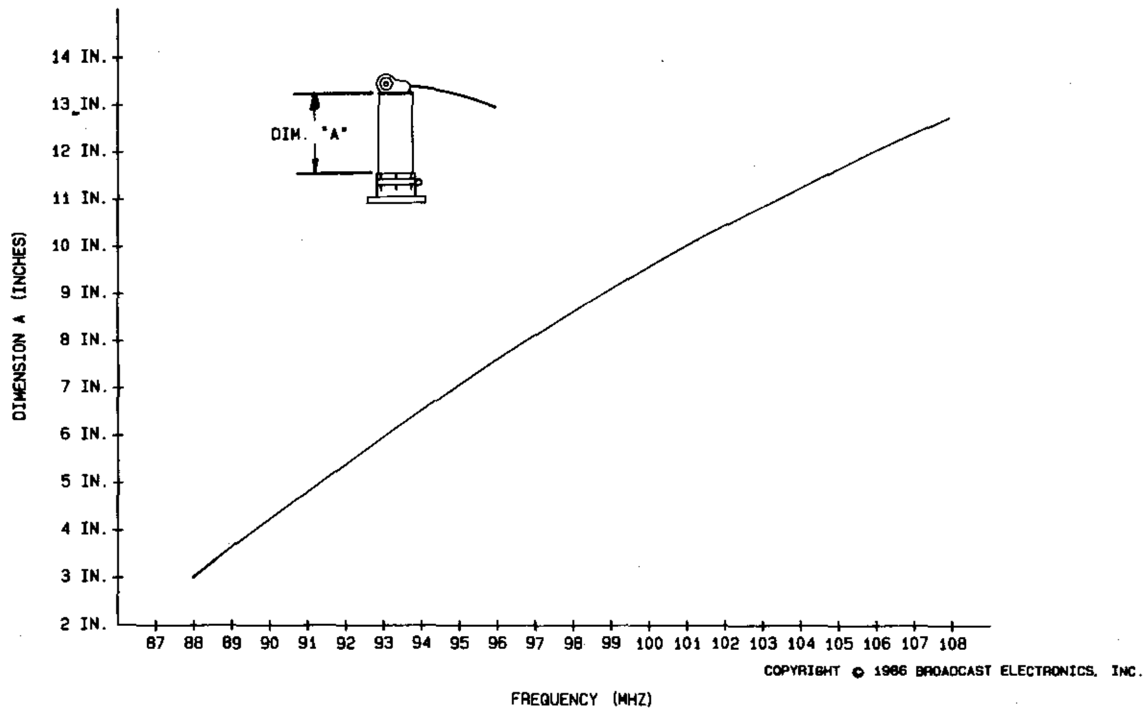
5-105. Refer to SECTION II, INSTALLATION and perform the PRELIMINARY OPERATION AND TUNING PROCEDURE. Tune the transmitter for 50% of the rated output power level. Use a spectrum analyzer to monitor spurious activity during tuning and use an in-line wattmeter for all output power indications.

5-106. Refer to the adjustment procedures in the preceding text and perform the SECOND HARMONIC SUPPRESSOR adjustment procedure.

5-107. Refer to the adjustment procedures in the preceding text and perform the NEUTRALIZATION adjustment procedure.

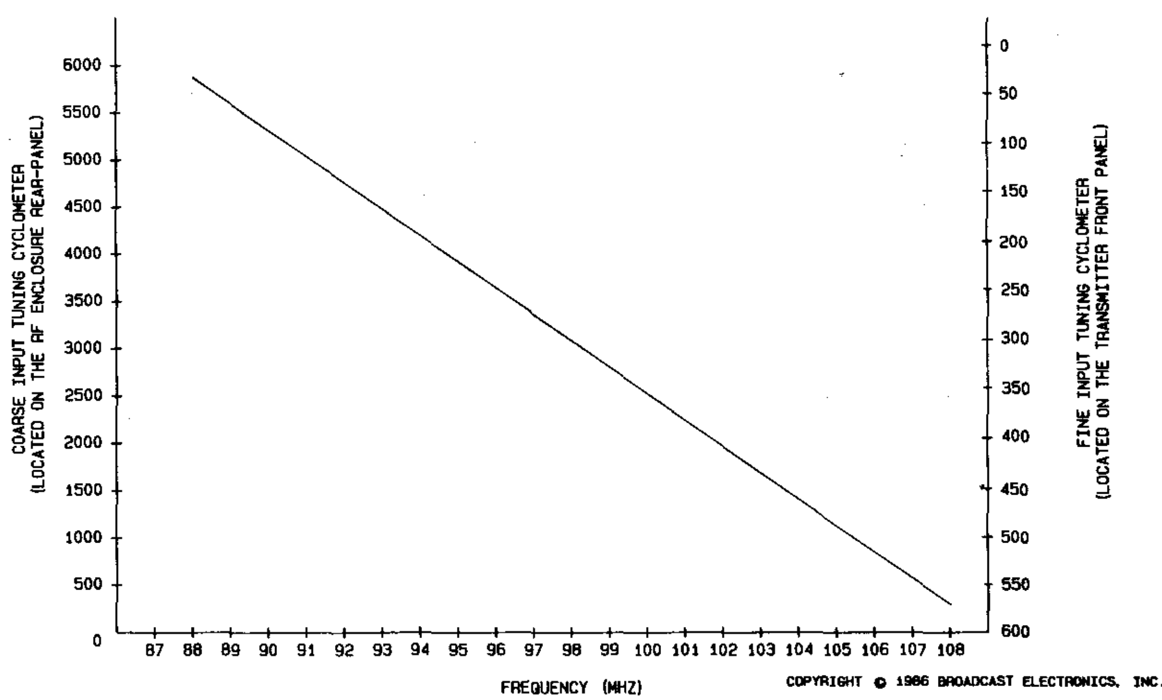
5-108. Refer to SECTION II, INSTALLATION and complete the PRELIMINARY OPERATION AND TUNING PROCEDURE. Tune the transmitter for 100% of the rated output power level.

A



FM-10A COARSE OUTPUT TUNING

B



FM-10A COARSE INPUT TUNING

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FIGURE 5-5. COARSE TUNING ADJUSTMENTS

5-109. Refer to APC SECTION II, MAINTENANCE and perform the FWD CAL and RFL CAL adjustment procedures.

5-110. Refer to the IPA SECTION II, MAINTENANCE and perform the REFLECTED POWER NULL adjustment procedure.

5-111. TROUBLESHOOTING.

WARNING WARNING WARNING	NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.

5-112. Most troubleshooting consists of visual checks. Due to the dangerous voltages and currents in the equipment, it is considered extremely hazardous to work with power energized. Therefore, the various transmitter indicators (meters, LEDs, fuses, and circuit breakers) should be used to isolate the malfunction to one of the specific areas listed below. Typical meter indications are presented in Table 5-1 and typical transmitter primary power demand requirements are listed in Table 5-2.

TRANSMITTER TROUBLESHOOTING AREAS

A. Power Supplies
B. Exciter
C. IPA
D. Power Amplifier
E. Automatic Power Control Unit
F. Transmitter Controller
G. Transmitter Load

CAUTION CAUTION	MANY COMPONENTS IN THE TRANSMITTER ARE MOUNTED TO HEAT SINKS UTILIZING A FILM OF HEAT-SINK COMPOUND FOR THERMAL CONDUCTION.
CAUTION CAUTION	IF ANY SUCH COMPONENT IS REPLACED, ENSURE A THIN FILM OF A ZINC-BASED HEAT-SINK COMPOUND IS USED (BE P/N 700-0028) TO ASSURE GOOD HEAT DISSIPATION.

5-113. Once trouble is isolated, refer to the applicable section of this manual which presents the theory of operation and troubleshooting information for the respective assembly to assist in problem resolution. Figures 5-6 through 5-9 provide illustrations to assist in component location.

5-114. COMPONENT REPLACEMENT ON CIRCUIT BOARDS. Component replacement on printed circuit boards requires extreme care to avoid damage to the board traces.

TABLE 5-1. FM-10A TYPICAL METER INDICATIONS, 10 kW POWER OUTPUT

METER	INDICATION
OUTPUT POWER:	
FORWARD	100%
VSWR	1.2:1
PLATE CURRENT	2.0 A
PLATE VOLTAGE	6600 V
SCREEN VOLTAGE	800 V
SCREEN CURRENT	70 mA
GRID VOLTAGE	-200 V
GRID CURRENT	45 mA
FILAMENT VOLTAGE	7.0 V

TABLE 5-2. FM-10A TYPICAL POWER DEMAND, 10 kW POWER OUTPUT

AC LINE FREQUENCY	AC LINE VOLTAGE	AC LINE CURRENT
60 Hz	210 V	50 A PER PHASE
50 Hz	220 V	50 A PER PHASE
50 Hz	380 V	28 A PER PHASE

5-115. On all circuit boards, the adhesive securing the copper track to the board melts at almost the same temperature at which solder melts. A circuit board trace can be destroyed by excessive heat or lateral movement during soldering. Use of a small iron with steady pressure is required for circuit board repairs.

5-116. To remove a component from a circuit board, cut the leads from the body of the defective component while the device is still soldered to the board.

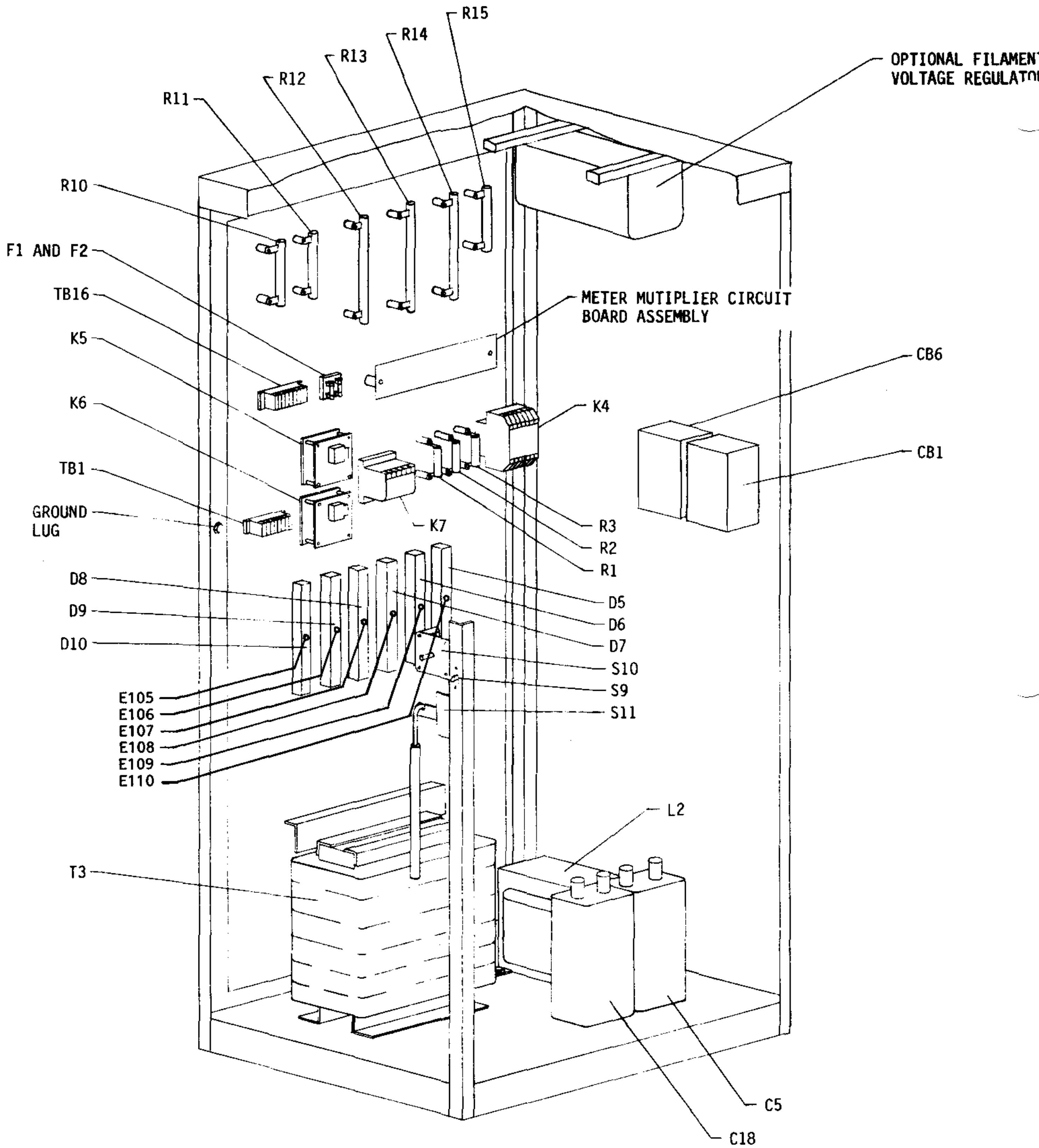
5-117. Grip each component lead, one at a time, with long nose pliers. Turn the board over and touch a soldering iron to the lead at the solder connection. When the solder begins to melt, push the lead through the back side of the board and cut off the bent-over outer end of the lead. Each lead may now be heated independently and pulled out of each hole. The holes may be cleared of solder by carefully re-heating with a low wattage iron and removing the residual solder with a soldering vacuum tool.

5-118. Install the new component and apply solder from the bottom side of the board.

<u>WARNING</u> <u>WARNING</u> <u>WARNING</u>	MOST SOLVENTS WHICH WILL REMOVE ROSIN FLUX ARE VOLATILE AND TOXIC BY THEIR NATURE AND SHOULD BE USED ONLY IN SMALL AMOUNTS IN A WELL VENTILATED AREA, AWAY FROM FLAME, INCLUDING CIGARETTES AND A HOT SOLDERING IRON.
<u>WARNING</u>	OBSERVE THE MANUFACTURER'S CAUTIONARY INSTRUCTIONS.

5-119. After soldering, remove flux with a cotton swab moistened with a suitable solvent. Rubbing alcohol is highly diluted and is not effective.

5-120. The board should be checked to ensure the flux has been removed and not just smeared about. Rosin flux is not normally corrosive, but rosin will absorb enough moisture in time to become conductive and cause problems.



597-0098-26

FIGURE 5-6. FM-10A POWER SUPPLY CABINET COMPONENT LOCATOR

WARNING: DISCONNECT POWER PRIOR TO SERVICING

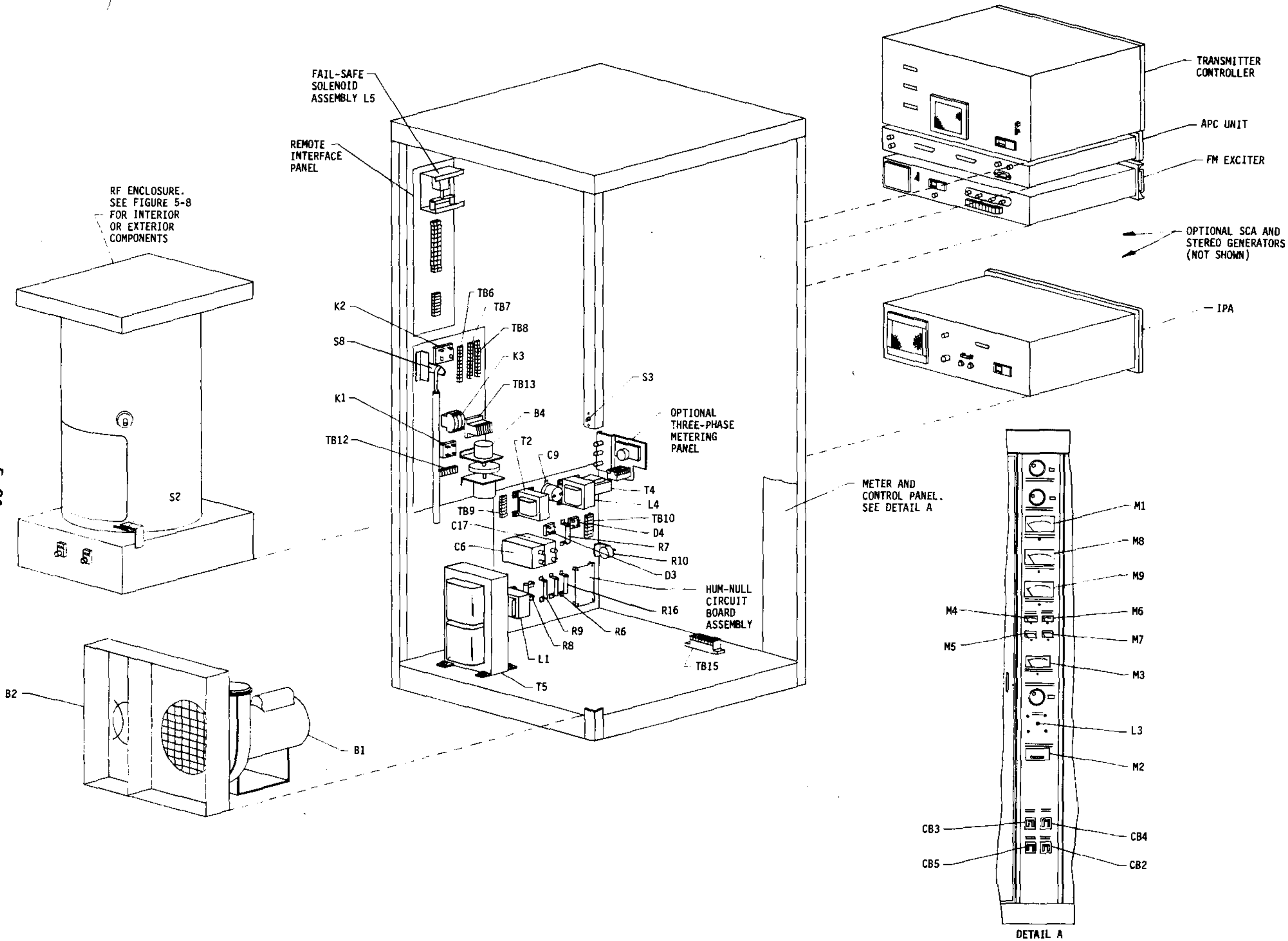
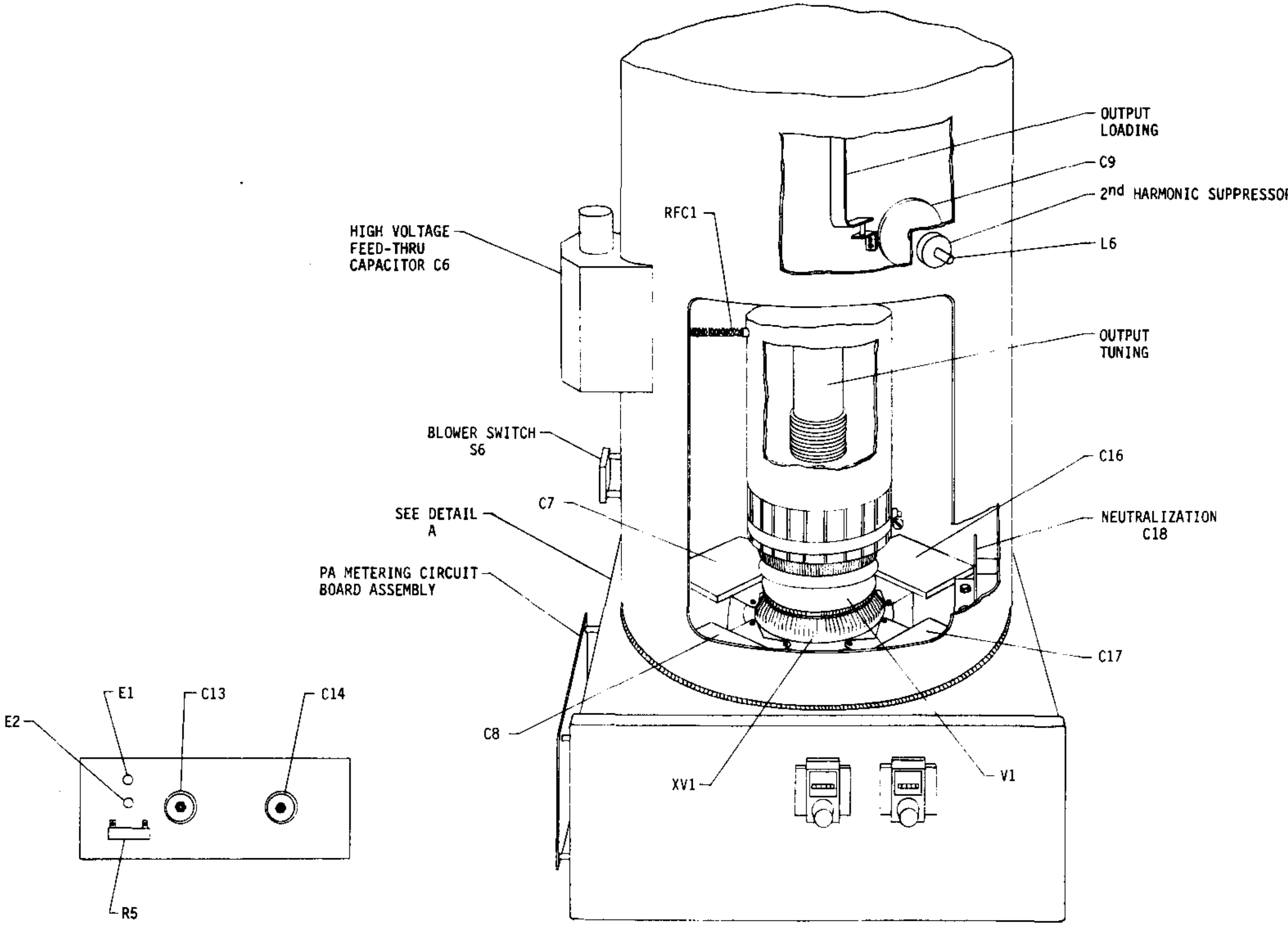


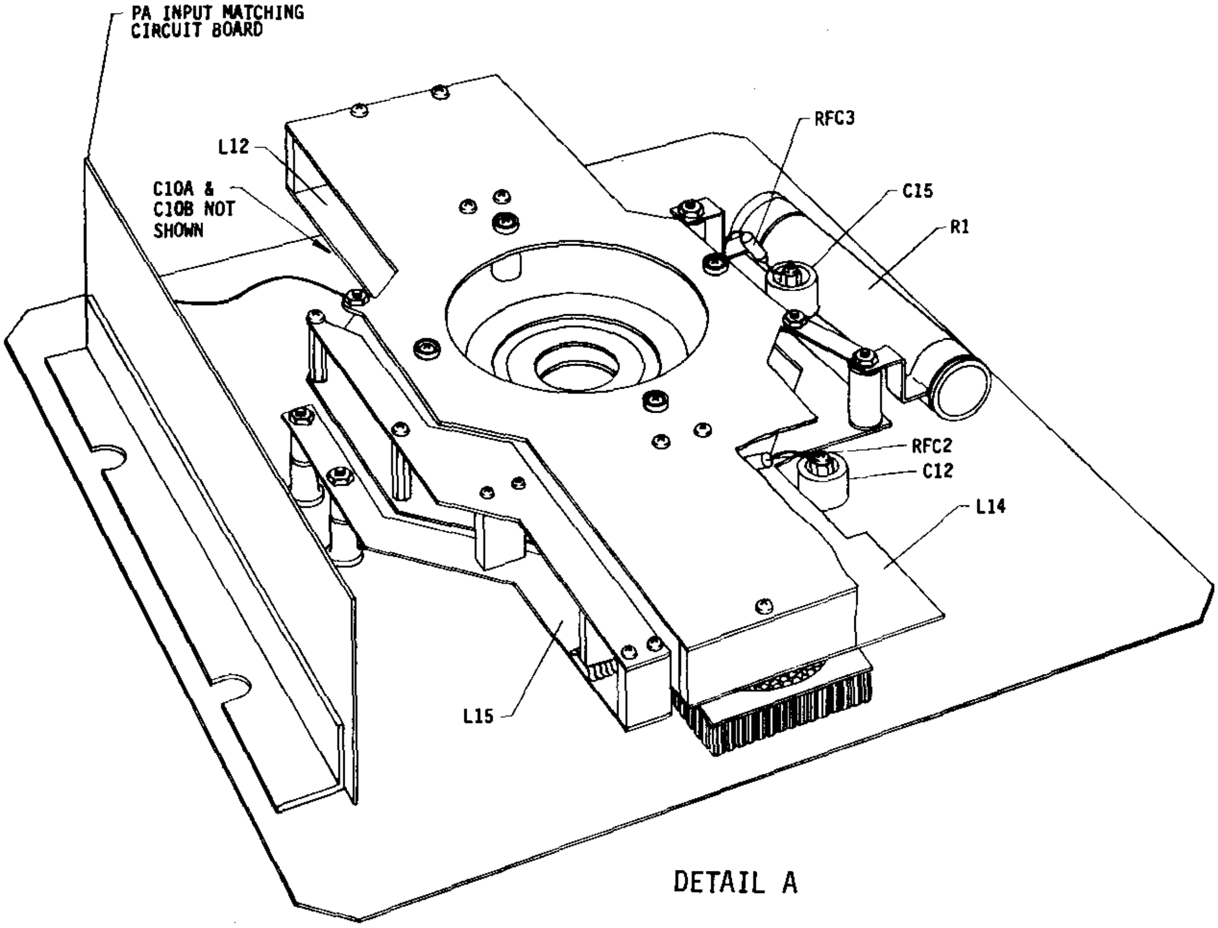
FIGURE 5-7. FM-10A PA/DRIVER CABINET COMPONENT LOCATOR

597-0098-27

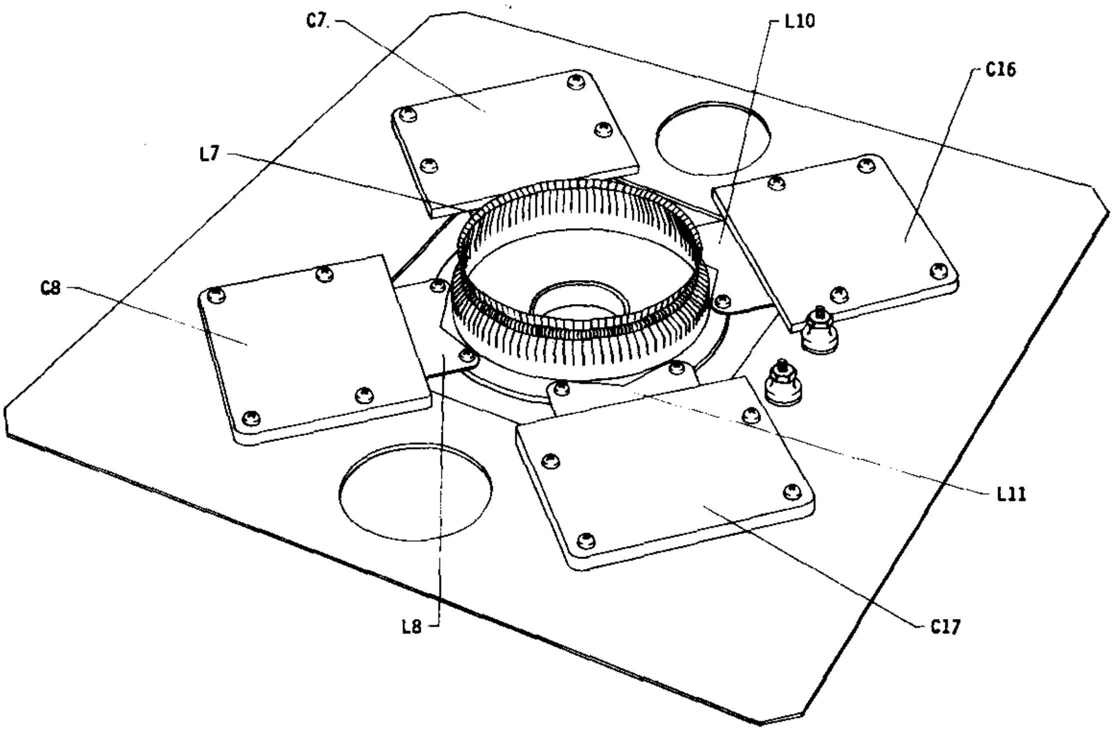


597-0098-28

FIGURE 5-8. PA CAVITY COMPONENT LOCATOR



DETAIL A



DETAIL B

597-0098-29

FIGURE 5-9. PA INPUT CIRCUIT COMPONENT LOCATOR

SECTION VI

PARTS LISTS

6-1. INTRODUCTION.

6-2. This section provides descriptions and part numbers of electrical components, assemblies, and selected mechanical parts required for maintenance of the Broadcast Electronics FM-10A FM Transmitter. Each table entry in this section is indexed by reference designators appearing on the applicable schematic diagram.

6-3. Parts for the IPA, APC unit, and the transmitter controller are listed in the modular publications of this manual.

TABLE 6-1. REPLACEABLE PARTS LISTS

TABLE 6-2. FM-10A TRANSMITTER - 909-1110-200/-201/-210/-211/-380/-381

REF. DES.	DESCRIPTION	PART NO.	QTY.
V1	PA Tube, Eimac, 4CX7500A	240-0001	1
----	Power Supply Cabinet Assembly	959-0233	1
----	Resistor Network Assembly (APC)	959-1000-023	1
----	Resistor Network Assembly (APC)	959-1000-008	1
----	Resistor Network Assembly (APC)	959-1000-009	1
----	Resistor Network Assembly (APC)	959-1000-025	1
----	Resistor Network Assembly (IPA)	959-1000-001	1
----	16-Pin DIP Jumper Assembly (APC)	959-1001	1
----	Output Directional Coupler Assembly	959-0082-001	1
----	Harmonic Low-Pass Filter, 10 kW, 88 to 108 MHz	339-0017	1
----	Transmission Line Conductor, Inner	463-6714	1
----	Transmission Line Conductor, Outer	463-6715	1
----	Flange, 3 1/8 inch	427-0001	2
----	Transmission Line Insulator-Connector Assembly	427-0004	1
----	Transmission Line Coupling, 3 1/8 inch to 1 5/8 inch	427-0051	1
----	Turnlock Fastener, 1/4 Turn		
	Stud	424-0008	2
	Retainer	424-0006	2
	FOR 60 Hz TRANSMITTER MODELS 909-1110-200/-201/-210/-211		
----	Power Amplifier/Driver Cabinet Assembly	959-0234	1
	FOR 50 Hz TRANSMITTER MODELS 909-1110-380/-381 50 Hz		
----	Power Amplifier/Driver Cabinet Assembly	959-0234-001	1
	FOR TRANSMITTER MODELS 909-1110-200/-201/-380/-381		
----	FX-30 Exciter, 220V ac 50/60 Hz Operation	909-0093	1
	FOR TRANSMITTTER MODELS 909-1110-201/-211/-381		
----	Assembly, Wiring Harness w/Remote Power Supply	949-0130	1

TABLE 6-3. FM-10A POWER SUPPLY CABINET ASSEMBLY - 959-0233
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C5,C18	Capacitor, Electrolytic, 4 uF, 8 kV	047-0004	2
CB1	Circuit Breaker, 3-Pole, 480V ac, 70 Amperes (HIGH VOLTAGE Circuit Breaker)	341-0042	1
CB6	Circuit Breaker, 3-Pole, 480V ac, 20 Amperes (CONTROL Circuit Breaker)	341-0044	1
D5 THRU D10	Power Rectifier, PIV: 18 kV, $V_{F_{MAX}}$ = 21.0V dc @ 1.85 Amperes	230-0009	6
E105 THRU E110	Spark Gap, 14,000 VDC ±2000 VDC	140-0019	6
F1,F2	Fuse, 20 Amperes, 250V, Slow-Blow	334-0020	2
K4	Contactor (Start Contactor) Coil: 220V ac 50/60 Hz Contacts: 3-Pole, 75 Amperes, 600V	341-0043	1
K5,K6	Assembly, Semi-Solid State Relay (Step Driver, Start Driver)	919-0096	2
K7	Contactor (Step Contactor) Coil: 110V to 230V ac 50/60 Hz Contacts: 3-Pole, 40 Amperes, 600V	341-0023	1
L2	Choke, 2.2 uH +20% -5%, 25 Ohms DC Resistance Maximum	360-4184	1
R1 THRU R3	Resistor, 2 Ohm ±5%, 50W, W/W	132-1004	3
R10,R11	Resistor, 22 Ohm ±20%, 150W	139-0220	2
R12 THRU R14	Resistor, 100 k Ohm ±5%, 175W	132-1064	3

TABLE 6-3. FM-10A POWER SUPPLY CABINET ASSEMBLY - 959-0233
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R15	Resistor, 22 Ohm ±20%, 150W	139-0220	1
T3	Transformer, (Plate Supply)	370-4183	1
	Primary: Three-Phase, 208/240V ±11V ac, 50/60 Hz, Delta Configuration		
	Secondary: Three-Phase, 4662V @ 2.32 Amperes, Wye Configuration		
TB1	Terminal Strip (AC Input)		
	Terminal, Single-Section, CC-6	412-0041	4
	End Cover	412-0043	1
	End Clamp	412-0042-001	2
	Channel, CH-236,	412-0044	2.76
TB16	Barrier Strip, Single-Section, 600V	412-0725	10
XF1/XF2	Holder, Fuse, 2-Pole	415-0003	1
----	Interlock Switch, Micro, Door, SPDT, 0.5A @125V dc	346-3302	1
----	Jack, Banana, 1 kV, Capacitance: 7.0 pF	417-0109	2
----	Meter Multiplier Assembly	919-0079	1
----	Power Supply Cable Harness Assembly	949-0129	1
----	Ground Stick Hanger Assembly	955-0038	1
----	Ground Stick Assembly	959-0145	1
----	Assembly, Wiring Harness w/Adjacent Power Supply	949-0131	1

TABLE 6-4. METER MULTIPLIER ASSEMBLY - 919-0079

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
D1	Diode, Zener, 1N4739A, 9.1V ±5%, 1W	200-0009	1
R1 THRU R10	Resistor, 1 Meg Ohm ±1%, 2W	140-0003	10
R11	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
----	Blank Circuit Board	519-0079	1

TABLE 6-5. SOLID STATE RELAY ASSEMBLY - 919-0096

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Ceramic Disc, 0.001 uF, 1 kV	002-1034	1
C2	Capacitor, Electrolytic, 100 uF, 35V	020-1083	1
C3	Capacitor, Ceramic Disc, 0.03 uF, 300V	000-1051	1
D1	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	1
D2	Diode, Zener, 1N5359, 24V, 5W	200-5359	1
D3,D4	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	2
E1 THRU E5	Terminal, Male, 0.25 Tab	410-0064	5
F1	Fuse, PCB Mount, 250V, 1/2 Ampere	330-0052	1
K1	Relay,	270-0054	1
	Coil: 24V dc, 30A, 660 Ohms ±10% dc Resistance		
	Contacts: SPST, 0.5 to 15A @ 12 to 240V dc		
MOV1	Metal Oxide Varistor, V250LA15A, 250V AC RMS	140-0008	1
R1	Resistor, 4 k Ohm ±5%, 10W	130-4044	1
R2	Resistor, 560 Ohm ±5%, 1/2W	110-5633	1
R3	Resistor, 820 Ohm ±5%, 1/2W	110-8233	1
U1	Integrated Circuit, 4N33, Optical Isolator, Infared LED-Photo NPN Darlington Transistor Coupled Pair, 1500V Isolation	229-0033	1
XU1	Socket, 6-Pin DIP	417-0600	1
----	Blank Circuit Board	519-0096	1

TABLE 6-6. POWER SUPPLY CABLE HARNESS ASSEMBLY - 949-0129

REF. DES.	DESCRIPTION	PART NO.	QTY.
P15	Connector, D-Type, 9-Pin	418-0037	1
----	Pins, Connector	417-0142	9
----	Plug, Banana, 25 Ampers AC	418-0039	1

TABLE 6-7. GROUND STICK HANGER ASSEMBLY - 955-0038

REF. DES.	DESCRIPTION	PART NO.	QTY.
-----	Microswitch, SPDT, 0.5A @ 125V dc	346-6100	1

TABLE 6-8. OUTPUT DIRECTIONAL COUPLER ASSEMBLY - 959-0082

REF. DES.	DESCRIPTION	PART NO.	QTY.
----	Directional Coupler Assembly	950-6906	2

TABLE 6-9. DIRECTIONAL COUPLER ASSEMBLY - 950-6906

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	Receptacle, BNC	417-0203	1
R215	Resistor, 68 Ohm ±5%, 2W	132-6832	1

TABLE 6-10. POWER AMPLIFIER/DRIVER CABINET ASSEMBLIES - 959-0234/-001
(Sheet 1 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
	60 Hz		
B1	Blower, 500 ft/min at 4.2 inches H_2O Motor: Single-Phase 110/220V ac, 3450 RPM, 2 hp	380-0010	1
	50 Hz		
B1	Blower, Centrifugal, 420 ft/min at 2.9 inches H_2O Motor: Single-Phase 110/220V ac, 2850 RPM, 2 hp	380-0010-001	1
B2	Fan, 6-Inch (15.24 cm), 250 ft^3/min, 220V ac, 50/60 Hz, 40 Watt	380-7650	1
C1	Capacitor, Ceramic Disc, 0.001 uF, 1 kV	002-1034	1
C6	Capacitor, Mylar, 10 uF, 2 kV	047-0002	1
C9	Capacitor, Electrolytic, 80 uF, 450V	028-8076	1
C10 THRU C16	Capacitor, Ceramic Disc, 0.001 uF, 1 kV	002-1034	7
C17	Capacitor, Mylar, 10 uF, 2 kV	047-0002	1
CB2	Circuit Breaker, 2-Pole, 240V, 30 Amperes (BLOWER Circuit Breaker)	341-0047	1
CB3	Circuit Breaker, 2-Pole, 250V, 2 Amperes (SCREEN Circuit Breaker)	341-0009	1
CB4	Circuit Breaker, 2-Pole, 250V, 7 Amperes (DRIVER Circuit Breaker)	341-0025	1
CB5*	Circuit Breaker, 2-Pole, 250V, 10 Amperes (FILAMENT Breaker)	341-0030	1
D3,D4	Bridge Rectifier, H440, Peak Reverse Voltage: 4 kV DC Forward Current: 750 mA Forward Voltage @ 150 mA dc: 6V	239-0440	2
D8	Diode, MR506, 600V, 3 Amperes	203-0506	1
J2	Housing, Connector, 4-Pin	418-0233	1
K1	Assembly, Semi-Solid State Relay (Blower Driver)	919-0096	1
K2	Assembly, Semi-Solid State Relay (Control Contactor Driver)	919-0096	1

* (Not applicable if transmitter is equipped with filament voltage regulator option 909-0115 or 909-0116. Refer to the filament voltage regulator option Parts Description for the applicable circuit breaker.)

TABLE 6-10. POWER AMPLIFIER/DRIVER CABINET ASSEMBLIES - 959-0234/-001
(Sheet 2 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
K3	Contactor (Control Contactor), Coil: 208 to 240V, 60 Hz or 208 to 220V, 50 Hz Contacts: 3 Sets SPST, 25A, 600V	341-0033	1
L1	Choke, 10 Henrys, 0.4A, 2500 Volt Insulation, 92 Ohm dc Resistance	377-0002	1
L3	Transformer, Variable, 0-40V, 6 kVA, 21-40, PWS	374-0001-1	1
L4	Choke, 10 Henrys, 0.4A, 2500 Volt Insulation, 92 Ohm dc Resistance	377-0002	1
M1	Meter, 4.5 inch (11.4 cm), Taut Band Type, FS = 200 uA dc ±1%, 208 Ohm Movement (OUTPUT POWER Meter)	310-0004-2	1
	60 Hz		
M2	Meter, Ø - 99, 999.9 Hour, Non-Resettable, 230 Volt, 3.5 inch (8.89 cm) (FILAMENT TIME Meter)	310-0000	1
	50 Hz		
M2	Meter, Ø - 99, 999.9 Hour, Non-Resettable, 230 Volt, 3.5 inch (8.89 cm) (FILAMENT TIME Meter)	310-0000-001	1
M3	Meter, 3.5 inch (8.89 cm), Iron Vane Type, Ø-10V AC ±3% Movement (FILAMENT VOLTAGE Meter)	310-0024	1
M4	Meter, 1.5 inch (3.8 cm), Taut Band Type, FS = 1 mA ±2%, 15 Ohm Movement (SCREEN VOLTAGE Meter)	317-0002-1	1
M5	Meter, 1.5 inch (3.8 cm), Taut Band Type, FS = 200 mA Movement, 0.25 Ohm Internal Resistance (SCREEN CURRENT Meter)	310-0015	1
M6	Meter, 1.5 inch (3.8 cm), Taut Band Type, FS = 1 mA ±2%, 15 Ohm Movement (GRID VOLTAGE Meter)	317-0008	1
M7	Meter, 1.5 inch (3.8 cm), Taut Band Type, FS = 100 mA ±2%, 0.5 Ohm Movement (GRID CURRENT Meter)	310-0014	1
M8	Meter, 4.5 inch (11.4 cm), Taut Band Type, FS = .75V 1k Ohm / Volt Movement (PLATE CURRENT Meter)	310-0036	1
M9	Meter, 4.5 inch (11.4 cm), Taut Band Type, FS = 1 mA ±1%, 15 Ohm Movement (PLATE VOLTAGE Meter)	317-0001-1	1
R6	Resistor, Adjustable, 5 k Ohm ±5%, 50W, W/W	180-0578	1
R7	Resistor, 2 k Ohm ±5%, 25W, W/W	132-0207	1
R8	Resistor, 10 k Ohm ±5%, 100W, W/W	132-1053	1
R9	Resistor, 7.5 k Ohm ±5%, 50W, W/W	132-7543	1
R10	Potentiometer, 50 Ohm ±10%, 25W, W/W	195-0149-001	1
R14	Resistor, Adjustable, 5 k Ohm ±5%, 50W, W/W	180-0578	1
S1,S3	Interlock Switch, SPDT, 0.5A @ 125V dc (PA Cabinet Lower Front Access Panel and Rear Door Interlocks)	346-3302	2
T2	Transformer (Screen Supply) Primary: 208/240V %11V ac 50/60 Hz, Single-Phase Secondary: 1110V @ 0.15A Continuous, 15 Ohm dc Resistance	370-0007	1
T4	Transformer, (Bias Supply) Primary: 208/240V ±11V ac 50/60 Hz, Single-Phase Secondary: 1: 225V @ 0.2A Continuous 2: 253V @ 0.2A Continuous 3: 281V @ 0.2A Continuous 4: 310V @ 0.2A Continuous 1500 Volt Insulation, 70 Ohm dc Resistance	370-0006	1
	60 Hz		
T5	Transformer, Filament Primary: 208/240V ±11V 60 Hz, Single-Phase Secondary: 7.7V ac @ 120A Continuous	370-4185	1
	50 Hz		
T5	Transformer, Filament Primary: 208/240V ±11V 50 Hz, Single-Phase Secondary: 7.7V ac @ 120A Continuous	370-4698	1

TABLE 6-10. POWER AMPLIFIER/DRIVER CABINET ASSEMBLIES - 959-0234/-001
(Sheet 3 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
TB6 THRU TB8	Barrier Strip, 7 Terminal	412-0022	3
TB9	Barrier Strip, 10 Terminal	412-0010-1	1
TB10	Barrier Strip, 5 Terminal	412-0005-1	1
TB12	Barrier Strip, 4 Terminal	412-0011	1
TB13,TB15	Barrier Strip, Single-Section, 600V (10 For TB15, 7 For TB13)	412-0725	17
----	Ground Stick Assembly	959-0145	1
----	Ground Stick Hanger Assembly	955-0038	1
----	Cable Assembly, Power Amplifier/Driver Cabinet	949-0128	1
----	Hum Null Circuit Board Assembly	919-0103	1
----	Assembly, Screen Powerstat	959-0121	1
----	RF Enclosure Assembly	959-0230	1
----	Remote Interface Panel Assembly	959-0117	1
----	Assembly, IPA	959-0131	1
----	Assembly, Transmitter Controller	959-0046	1
----	Assembly, Automatic Power Control Unit	959-0243	1

TABLE 6-11. CABLE ASSEMBLY, POWER AMPLIFIER/DRIVER CABINET - 949-0128

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	Connector, Housing, 6-Pin	418-0670	1
J1	Connector, Housing, 12-Pin	418-1271	1
J1	Connector, Ribbon Cable, 26-Pin	417-0047	1
J15	Connector, D-Type, 9-Pin	417-0901	1
P1	Connector, D-Type, 25-Pin	418-0609	1
P1,P2	Connector, Housing, 4-Pin	418-0240	2
P2,P3,P8,P9	Connector, Housing, Male, 25-Pin	418-3219	4
----	Connector, Plug, BNC APC: P9, P10 Directional Coupler: RFL, FWD Exciter: RF OUTPUT IPA: RF INPUT	417-0094	6
----	Connector, Jack, Type-N (IPA: P13, RF Enclosure: P1)	418-0031	2
----	Connector, Plug, Type-N (RF Enclosure, PA Input)	417-0076	1
----	Connector, Plug, BNC (RF Enclosure, PA Input)	417-0095	1
----	Receptacle, Pins	417-0036	3
----	Socket, Pins (For J15)	417-0143	9
----	Pins, Connector (For 4-Pin, 6-Pin, and 12-Pin Connectors)	417-0053	22

TABLE 6-12. HUM NULL CIRCUIT BOARD ASSEMBLY - 919-0103

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Electrolytic, 470 uF, 50V	024-4783	1
F1,F2	Fuse, AGC, 250V, 0.50 Ampere	330-0050	2
T1	Transformer, Circuit Board Mount Primary: 600 Ohm Impedance Secondary: 600 Ohm Impedance, +15 dBm Maximum Output Level	371-0009	1
TB1	Barrier Strip, 4 Terminal	411-0815	1
XF1,XF2	Fuse Clip, AGC	415-2068	4
----	Blank Circuit Board	519-0063	1

TABLE 6-13. POWERSTAT ASSEMBLY - 959-0121

REF. DES.	DESCRIPTION	PART NO.	QTY.
B4	Motor, Gearhead, 24V dc @ 235 mA, 9.1 r/min, Torque: 240 oz/in.	381-0001	1
D1,D2	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	2
S4,S5	Microswitch, SPDT, 125V @ 4 Ampere (Limit Switches)	346-6100-1	2
T1	Autotransformer, Variable Input: 240V 50/60 Hz, Output: 0-240V @ 0.7A	374-0003	1
TB5	Barrier Strip, 4 Terminal	412-0011	1

TABLE 6-14. RF ENCLOSURE ASSEMBLY - 959-0230

REF. DES.	DESCRIPTION	PART NO.	QTY.
C9	Capacitor, Plate, Second Harmonic Suppressor	474-0187	1
C13,C14	Capacitor, 700 pF, 1.5 kV, Filament Feedthru:		
	Kapton Dielectric	519-0039	4
	Teflon Spacer	441-0054-001	2
E1	Spark Gap, 1000V dc ±20% Breakdown, 5000A Discharge Maximum	140-0015	1
E2	Spark Gap, 2500V dc ±20% Breakdown, 2500A Discharge Maximum	140-0016	1
J2	Connector, BNC	417-0203-1	1
J3	Jack, Banana	417-0074	1
L6	Inductor, Second Harmonic Suppressor	463-0047	1
L9	Chimney, PA	459-0132	1
L10	Assembly, Bellows, Output Tuning Line	463-0043	1
P3	Plug, Banana, Uninsulated	418-0007	1
R5	Resistor, 250 Ohm, 25W, W/W	130-2503	1
RFC1	Inductor, RF Choke (Plate Circuit Connection)	360-0028	1
S2	Microswitch, SPDT, Roller Activated	346-3300	1
S6	Air Switch, 1823-2 Contacts: SPST, 15A @ 120V to 480V ac Operating Range: 0.5 to 5.0 inch/water	340-0011	1
----	Output Tuning Line, 23.62 inches (60 cm) X 1 5/8 inch OD	463-0042	1
----	Coupling, Unflanged, 1 5/8 inch	427-0007	4
----	Elbow, 1 5/8 inch Copper, 90 degrees, equal legs	427-0006	1
----	Flange, 1 5/8	427-0010	1
----	Transmission Line Elbow, Modified With Sampling Port	427-0006-001	1
----	Transmission Lines:		
	Outer, 5.19 inches (13.2 cm)	427-0008-005	1
	Inner, 4.31 inches (10.9 cm)	427-0008-007	1
	Outer, 31.35 inches (79.6 cm)	427-0008-006	1
	Inner, 30.47 inches (77.4 cm)	427-0008-008	1
	Outer, 9.1 inch (23.1 cm)	427-0008-010	1
	Inner, 8.22 inches (20.9 cm)	427-0008-011	1
----	Fingerstock, PA Cavity Access	469-0368	12
----	High Voltage Feed-Thru Capacitor Assembly	955-0049-002	1
----	Tube Socket and Input Tuning Assembly	959-0231	1
----	PA Metering Circuit Board Assembly	919-0062-002	1
----	Filament Cable Assembly, No 128	949-0042	1
----	Filament Cable Assembly, No 129	949-0043	1

TABLE 6-15. TUBE SOCKET AND INPUT TUNING ASSEMBLY - 959-0231
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C7,C8	Capacitor, Kapton, 1000 pF, 2 kV (Screen Bypass)	519-0095	2
C10	Capacitor, Kapton, 2000 pF, 1.5 kV (Grid Blocking)	519-0038	1
C12,C15	Capacitor, Ceramic, 500 pF ±20%, 5 kV	008-5024	2
C16,C17	Capacitor, Kapton, 1000 pF, 2 kV, (Screen Bypass)	519-0095	2
FL1,FL2	Feedthru - Grid and Screen, 1200 pF, 2500V, 25A Maximum	339-0012	2
L7,L7A,L8, L8A,L10,L10A, L11,L11A	Inductor, Plates, Neutralization	474-0288	4

TABLE 6-15. TUBE SOCKET AND INPUT TUNING ASSEMBLY - 959-0231
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
L12,L14	Grid Tuning Assembly:		
	Top Plate	474-0289	1
	Bottom Plate	474-0290	1
	Shorting Bar	459-0131	1
R1	Resistor, 750 Ohm, 50W, Non-Inductive	139-0002	1
RFC2,RFC3	Choke, 80 to 200 MHz, 1100 mA Maximum	360-0144	2
XV1	Socket, Eimac, SK-350	417-0350	1
----	Power Amplifier Input Matching Circuit Board Assembly	919-0064-001	1
----	Filament Cable Assembly	949-0041	2

TABLE 6-16. POWER AMPLIFIER INPUT MATCHING CIRCUIT BOARD ASSEMBLY - 919-0064-001

REF. DES.	DESCRIPTION	PART NO.	QTY.
J2	Receptacle, BNC	417-0014	1
----	Blank Circuit Board	519-0064	1
----	Blank Circuit Board, Top, Matching	519-0064-001	1

TABLE 6-17. PA METERING CIRCUIT BOARD ASSEMBLY - 919-0062-002

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THUR C6	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	6
D1 THRU D5	Diode, Zener, 1N4739A, 9.1V ±5%, 1W	200-0009	5
F1,F2	Fuse, AGC, 1 Ampere, Fast-Blow	330-0100	2
F3	Fuseable Link, 28 Ga.	630-2806	.208
J1	Connector, Housing, 12-Pin	417-1276	1
J2	Connector, Housing, 6-Pin	417-0677	1
R1 THRU R3	Resistor, 500 k Ohm ±1%, 2W	140-0005	3
R4,R5	Resistor, 0.5 Ohm ±1%, 5W	130-5001	2
R6,R7	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	2
R8	Resistor, 10 Ohm ±5%, 1/2W	110-1023	1
R9	Resistor, 22 Ohm ±5%, 2W	130-2223	1
R10,R11	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R12	Resistor, 100 Ohm ±5%, 1/2W	110-1033	1
R13	Resistor, 47 Ohm ±5%, 1/2W	110-4723	1
R14	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R15 THRU R17	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	3
R18	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
XF1,XF2	Fuse Clips, AGC	415-2068	4
----	Blank Circuit Board	519-0062	1

TABLE 6-18. REMOTE INTERFACE PANEL ASSEMBLY - 959-0117

REF. DES.	DESCRIPTION	PART NO.	QTY.
TB2	Barrier Strip, 26-Terminal With Ribbon Cable Connector	412-0045	1
TB3	Barrier Strip, 6-Pin	412-0008	1
----	Fail-Safe Solenoid Assembly	959-0083	1

TABLE 6-19. FAIL-SAFE SOLENOID ASSEMBLY - 959-0083

REF. DES.	DESCRIPTION	PART NO.	QTY.
L5	Solenoid, 230V ac 50/60 Hz, DC Resistance: 360 Ohm ±10%	281-0004	1
TB11	Barrier Strip, 2-Terminal	412-0002	1
----	Barrier Strip, Insulated, 2-Terminal	407-0122	1

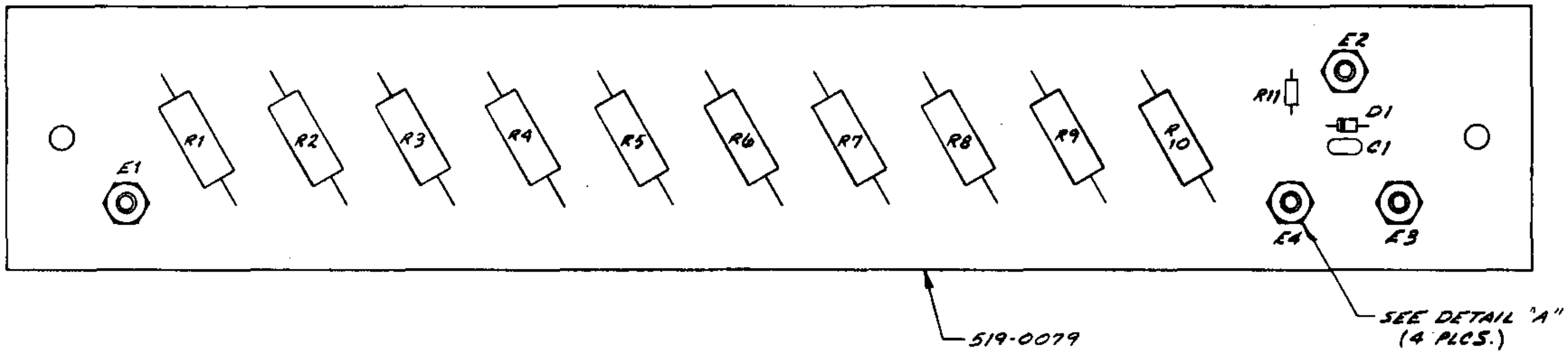
TABLE 6-20. REMOTE POWER SUPPLY INTERCONNECTING CABLE ASSEMBLY - 949-0130

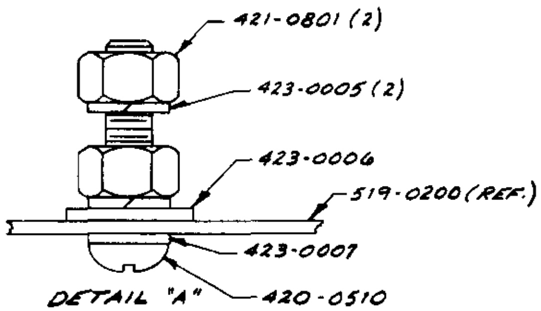
REF. DES.	DESCRIPTION	PART NO.	QTY.
P15	Connector, Housing, 9-Pin	418-0037	1
J15	Receptacle, Housing, 9-Pin	417-0901	1
----	Pins, Connector (For P15)	417-0142	9
----	Pins, Receptacle (For J15)	417-0143	9

SECTION VII
DRAWINGS

7-1. INTRODUCTION.

7-2. This section provides schematic diagrams and assembly diagrams as indexed below for the FM-10A transmitter.





DETAIL "A"
SCALE 2:1
4 PLCS.

SEE SCHEMATIC #B919-0079

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL±.01 3PL±.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL
SEE B/M 919-0079

DRAWN BY MERKEL DATE 1-20-84
CHECKED BY MW DATE 1-23-84
PROJECT ENGR. DATE
APPROVED BY

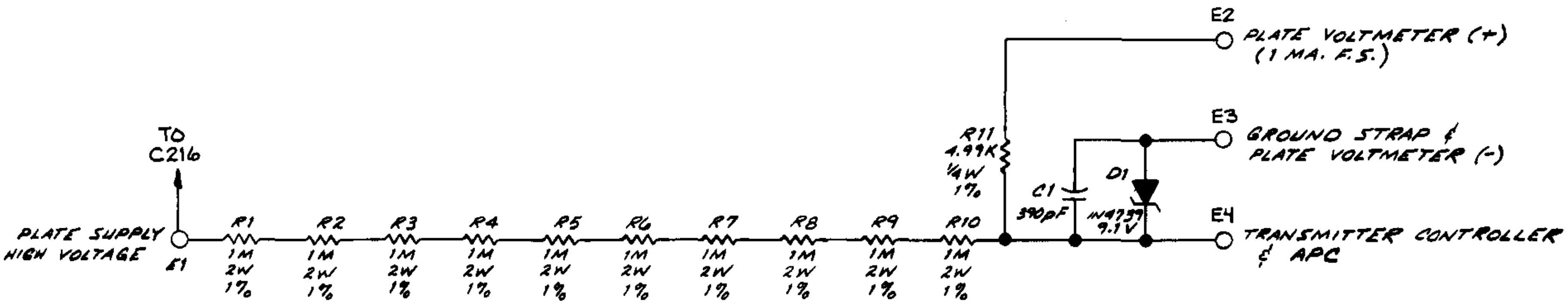
TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.

TITLE PCB ASSEMBLY
METER MULTIPLIER

B DWG. NO. TYPE A 919-0079 REV. A

FM 30A SCALE 1/1 SHEET 1 OF 1



NOTES:
1. ALL RESISTORS IN OHMS.
2. LAST COMPONENTS USED: C1, D1, E4, R11
3. SEE ASSEMBLY # B 919-0079
SEE B/M # 919-0079

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL ±.01 3PL ±.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL

TREATMENT OR FINISH

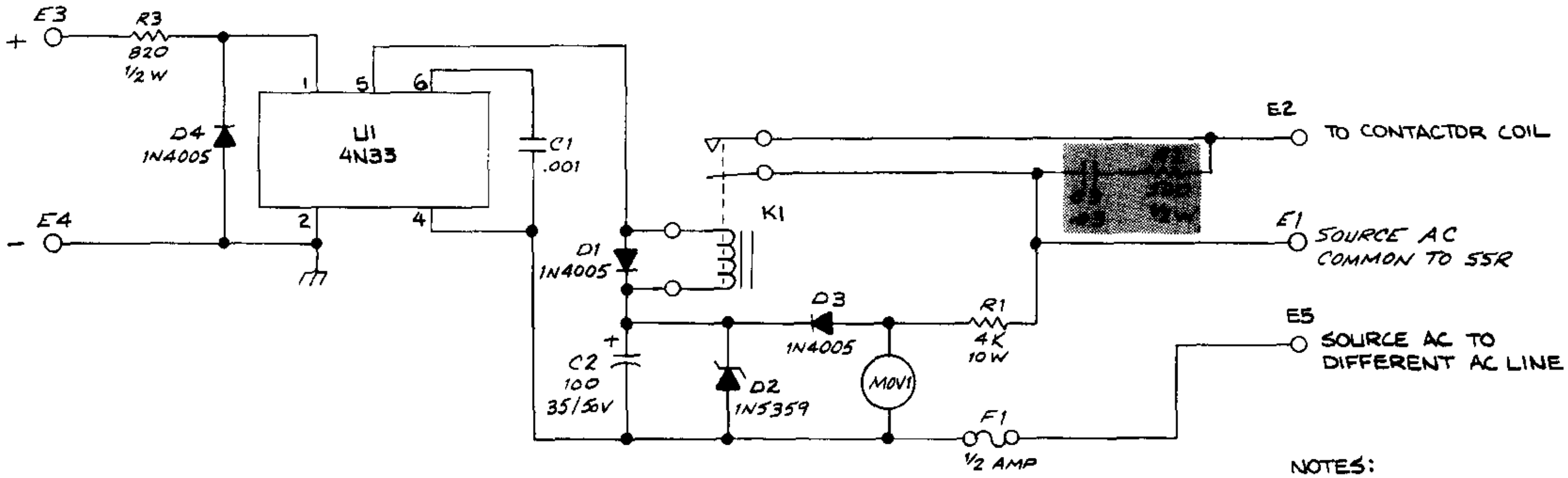
DRAWN BY MERKEL	DATE 1-23-84		
CHECKED BY MH	DATE 1-28-84		
PROJECT ENGR	DATE		
APPROVED BY			

BROADCAST ELECTRONICS INC.

TITLE PCB SCHEMATIC - METER MULTIPLIER

B DWG. NO. TYPE 5 919-0079 REV. A

FM30A SCALE — SHEET 1 OF 1



REQUIRES 4000 Ω FOR 3 Ø TRANSMITTERS

NOTES:
1) ALL RESISTORS IN OHMS, 1/4 W; 5%,
ALL CAPACITORS IN MICROFARADS, U.O.S.
2) COMPONENTS LAST USED: R3, C3, D4
S1, U1, F1, MOV1
3) SEE ASSY AC: 919-0096
4) SHADED COMPONENTS NOT USED
ON 919-0096-001

TOLERANCE (DECIMAL) U.O.S.
.x ± .030 xxx ± .005
.xx ± .015 ANGLES ± 1°

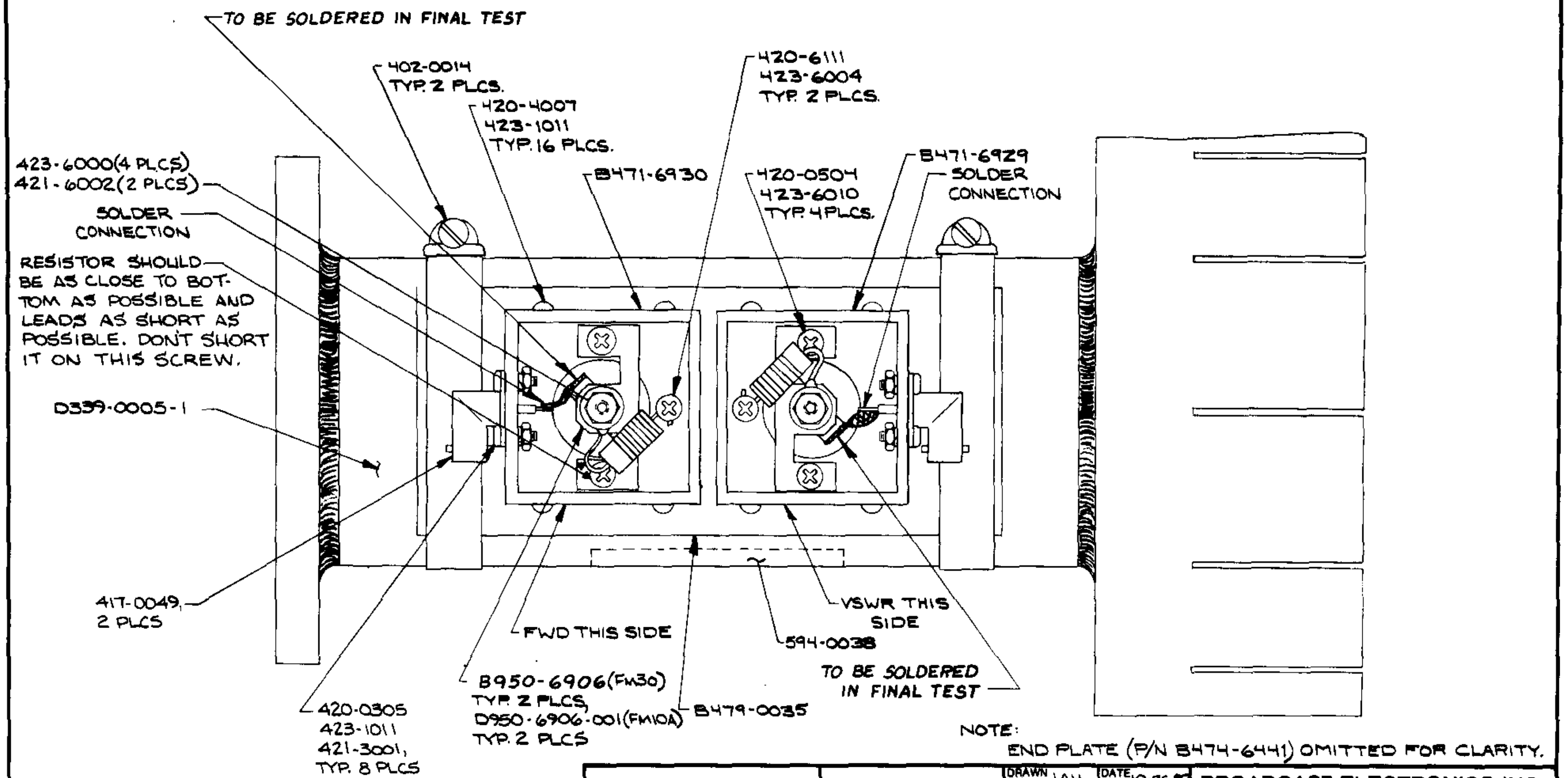
DWN. BY MSE 1-16-86	MATERIAL		
CHKD			
ME 7/14/86	FINISH		
PROJ. ENGR. 7-14-86			
MFG.	NEXT ASSY.		

BE BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE SCHEMATIC, S.S.R. SUBSTITUTE CONTACTOR INTERFACE

TYPE	SIZE	DWG. NO.	REV
S	B	919-0096, 919-0096-001	F

MODEL XTMRS SCALE ∼ SHEET 1 OF 1



TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL ±.01 3PL ±.005
FRACTIONAL ±1/64
ANGULAR ±1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL ———

DRAWN BY JAH	DATE 10-26-82
CHECKED BY	DATE
PROJECT ENGR. [illegible]	DATE 10-27-82
APPROVED BY MH 11-10-82	

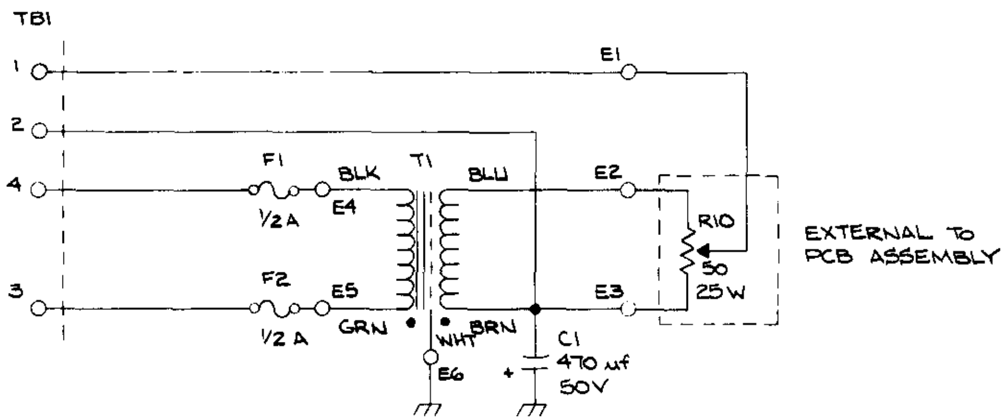
TREATMENT OR FINISH ———

BROADCAST ELECTRONICS INC.
—A FILMWAYS COMPANY—

TITLE ASSEMBLY, DIRECTIONAL COUPLER

B DWG. NO. 959-0082, 959-0082-001 REV. D

FM10A, FM30 SCALE 1/1 SHEET 1 OF 1



SEE PCB ASSY # C 919-0103

TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1

DWN. BY MSE 1-29-87
CHKD
ME
PROJ. ENGR.
MFG.

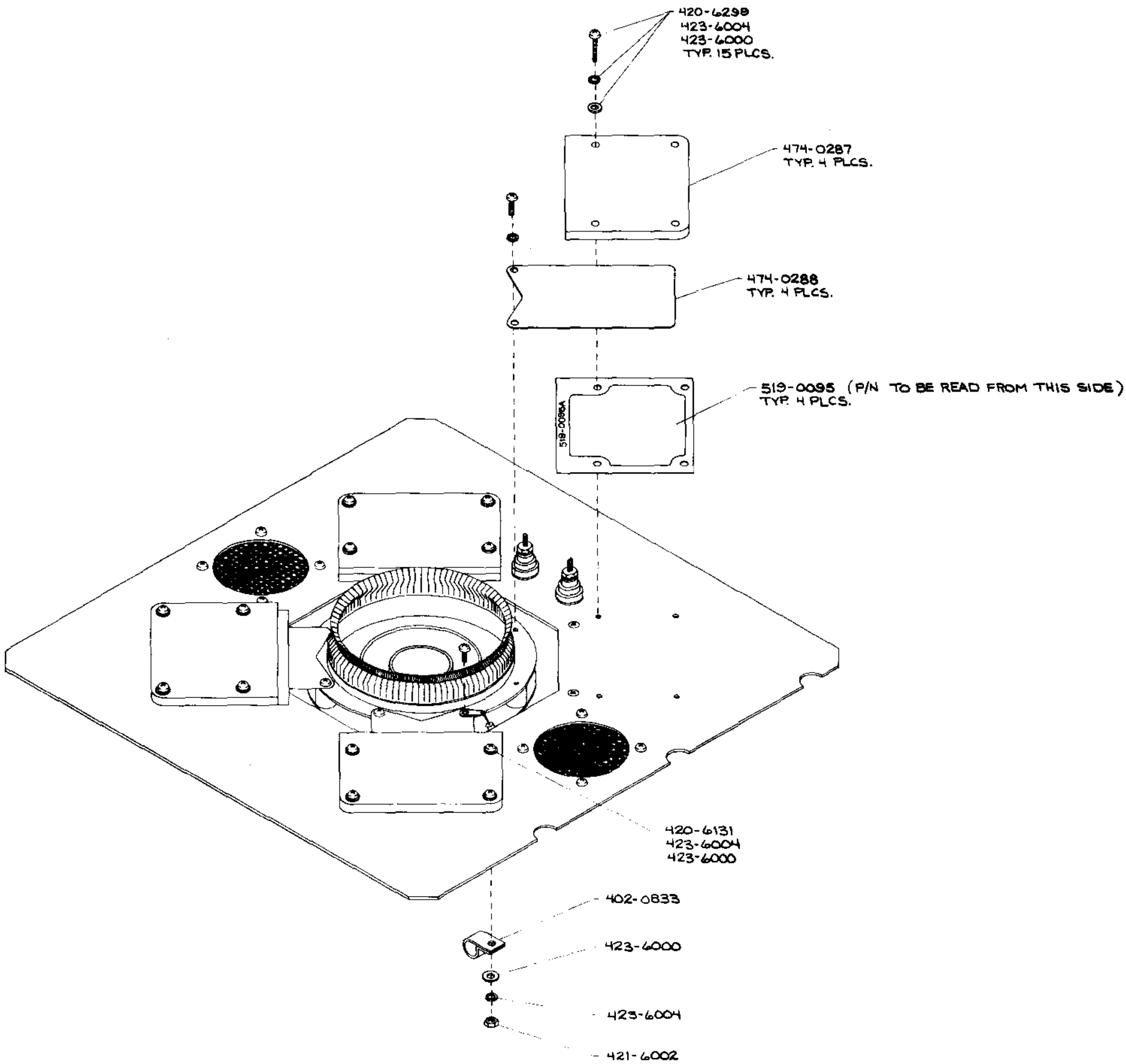
MATERIAL SEE B/M
FINISH
SEE DWG RA592-0000
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE SCHEMATIC, HUM NULL PCB

TYPE	SIZE	DWG. NO.	REV
S	B	919-0103	A

MODEL FM 10A | SCALE ~ | SHEET 1 OF 1



597-0098-100B

FIGURE 7-12. ASSEMBLY DIAGRAM, PA INPUT CIRCUIT
(Sheet 2 of 2)

APPENDIX A

MANUFACTURERS DATA

A-1. INTRODUCTION.

A-2. This appendix provides technical data associated with the operation and maintenance of the FM-10A transmitter. The information contained in this is appendix is presented in the following order.

A. Service Bulletin, Furnas Contactor, Size 75 Amp.

B. Service Bulletin, Furnas Contactor, Size 25 Amp.

C. Service Bulletin, Furnas Contactor, Size 40 Amp.

D. Operating Instructions and Parts List, Cincinnati Fan Company, LM-6C Volume Blower.

E. Optional Filament Voltage Regulator Operation and Service Manual.

F. Technical Data Sheet, Eimac, 4CX7500A Tetrode.

G. Aplication Paper, Eimac, Extending Transmitter Tube Life.

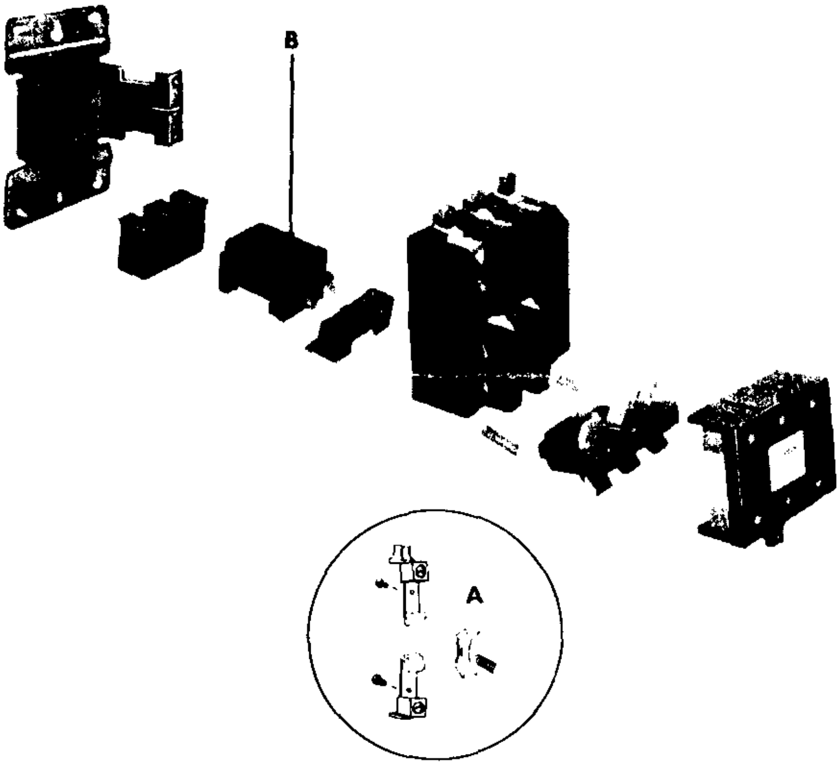
H. Technical Data Sheet, Thompson-CSF SD1460 VHF NPN Power Transistor.

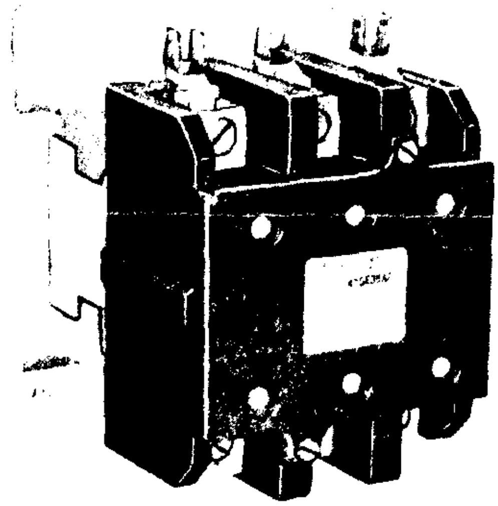
CLASS 42

REPLACEMENT PARTS

MAGNETIC CONTACTORS

File No.	42-GFE
Cat. No. or Class Series	42FE & 42GE
Size	75-90 AMPERE
Date	JUNE, 1974





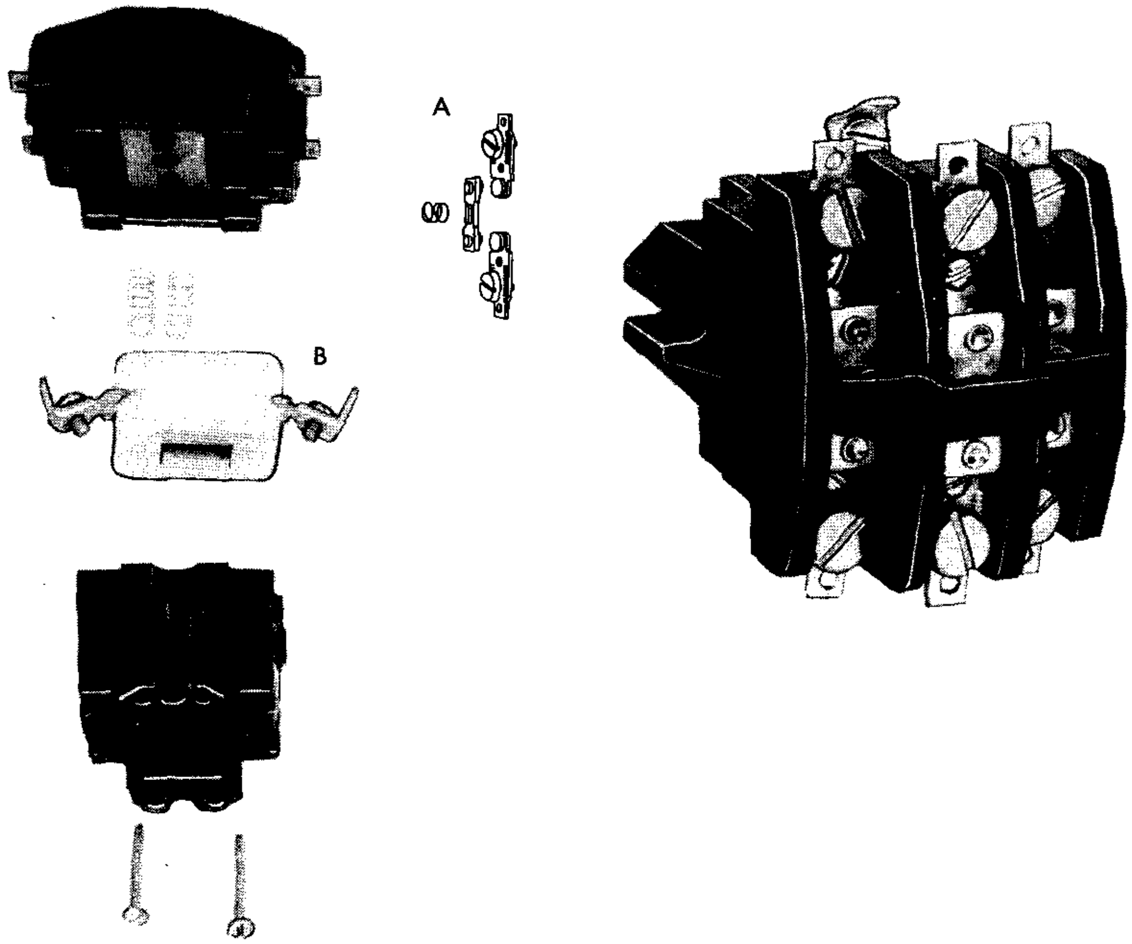
ITEM	PART NAME		PART NUMBER	
			75 AMP.	90 AMP.
A	Contacts & Spring, One complete pole		75FE42	75GE42
B	Coil, *60 Hertz	24 Volts	75D54772J	75D54772J
		120 Volts	75D54772F	75D54772F
		240 Volts	75D54772G	75D54772G
	*Other voltages and frequencies available on request	480 Volts	75D54772H	75D54772H

NOTE: When ordering replacement parts, give catalog number of control and part name and number.

REPLACEMENT PARTS

MAGNETIC CONTACTORS

File No.	41-GNB
Cat. No. or Class Series	41NB
Size	25 Amp
Date	APRIL, 1982



Item	Part Name		Part No.
A	Contacts & Spring, One complete pole		75NB41
B	Coil 60 Hz.	24 Volts	75D54760J
		120 Volts	75D54760F
		208-240 Volts	75D54760G
		440-480 Volts	75D54760H
		575-600 Volts	75D54760E

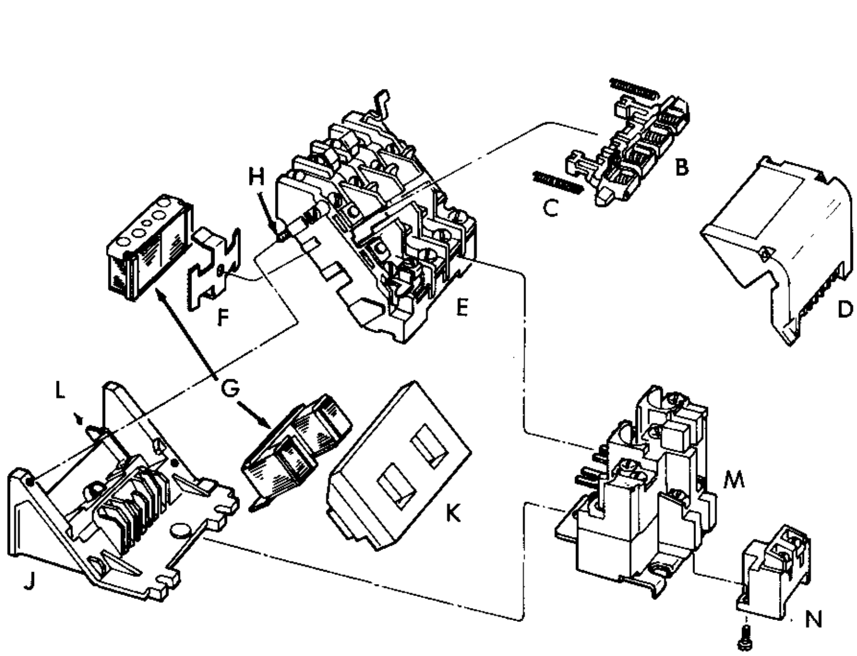
NOTE: When ordering replacement parts, give catalog number of control and part name and number.

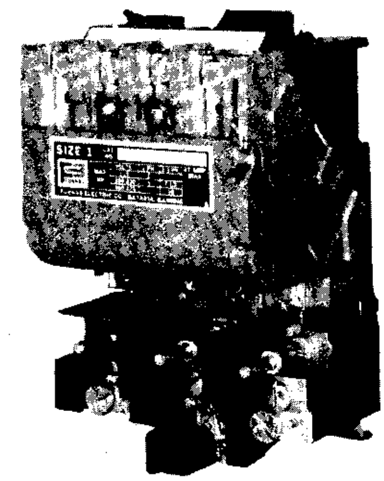
Furnas Electric Company — Batavia, Illinois, U.S.A.

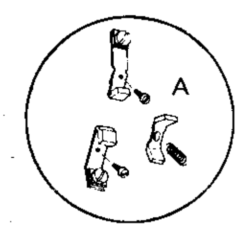
June, 1983
Supersedes Issue of
October, 1982

Starter & Contactors
00, 0, 1, 1P, & 1¾

Class 14 & 40
14BF, 14CF, 14DF, 14EF,
40BF, 40CF, 40DF, 40EF







Item	Part Name		Part Number			
			Size 00	Size 0	Size 1	Size 1P & 1¾
A	Contacts & Spring, One Pole	Power Pole	75BF14	75CF14	75DF14	75EF14
		Interlock Pole	75AF14	75AF14	75AF14	75AF14
B	Cross Arm (less contacts)		D28478001	D28478001	D28478001	D28478001
C	Cross Arm Springs		D24826001	D24826001	D24826001	D24826001
D	Contact Board Cover		D73062001	D73062001	D73062001	D73062001
E	Contact Board (less contacts)		D73116022	D73116022	D73116022	D73116022
F	Armature Spring Clip		D24817001	D24817001	D24817001	D24817001
G	Magnet and Armature		D25551001	D25551001	D255551001	D25551001
H	Contact Board Screw		D24827001	D24827001	D24827001	D24827001
J	Base		D74400001	D74400001	D74400001	D74400001
K	Coil					
	60 Hz 110-120/220-240v	50 Hz 110/190-220v	75D73070A	75D73070A	75D73070A	75D73070A
	220-240/440-480v	190-220/380-440v	75D73070C	75D73070C	75D73070C	75D73070C
	550-600v	550v	75D73070E	75D73070E	75D73070E	75D73070E
L	Coil Spring Clip		D24815001	D24815001	D24815001	D24815001
M	Overload Relays, Melting Alloy (std.)	1 Pole	48DC11AA2	48DC11AA2	48DC11AA2	48EC11AA2
		3 Pole	48DC31AA2	48DC31AA2	48DC31AA2	48EC31AA2
	Overload Relays, Bimetal	1 Pole	48DC17AA2	48DC17AA2	48DC17AA2	48EC17AA2
		3 Pole	48DC37AA2	48DC37AA2	48DC37AA2	48EC37AA2
	Overload Relays, Amb. Comp. Bimetal	1 Pole	48DC18AA2	48DC18AA2	48DC18AA2	48EC18AA2
		3 Pole	48DC38AA2	48DC38AA2	48DC38AA2	48EC38AA2
N	Melting Alloy Overload Kit NO Contacts		48ACNO	48ACNO	48ACNO	48ACNO
P	Auxiliary Interlock Pole NC		49D54682NC	49D54682NC	49D54682NC	49D54682NC

NOTE: When ordering replacement parts, give catalog number of control and part name and number.

OPERATING INSTRUCTIONS
AND
PARTS LIST

For
"PB" Pressure Blowers
"HP" Pressure Blowers
"LM" Volume Blowers
"ORB" Industrial Exhausters
Series FC and BI Utility Sets

WARNING

Rotating Equipment must be properly guarded to prevent personal injury.

By acceptance of this merchandise, the purchaser and user assume complete responsibility for the safe operation of this equipment. The manufacturer disclaims any and all responsibility unless this unit is operated in compliance with all federal and local laws and regulations.

CONTENTS

cincinnati fan and ventilator company, inc.
5345 Creek Road, Cincinnati, Ohio 45242, Area Code 513-984-0600

Cat. No. PMA-177

RECEIVING & START-UP

Receiving Inspection

When unit is received, inspect immediately for damaged or missing parts. Even though all units are carefully inspected and prepared for shipment at the factory, rough handling enroute may cause concealed damage or cause nuts,bolts or locking collars to work loose. Check wheel to see that it rotates freely and that there are no obstructions. Be certain all bolts and locking collars are tightened securley.

If concealed damage is found, call the carrier and ask for their Inspection Department. Then fill out a concealed damage inspection report.

Operation

Before Start Up

1. Inspect all fasteners to make sure they are secure.
   a. Foundation bolts
   b. Set screws in fan wheel and V-belt drive
   c. Housing, bearing and motor mounting bolts
2. Access Doors should be tight and sealed.
3. Bearings should be checked for alignment and lubrication.
4. Turn rotating assembly by hand to insure that it does not strike housing. If the wheel strikes the housing, the wheel may have moved on the shaft or the bearings may have shifted in transit. Correction must be made prior to start up.
5. Check motor to insure proper speed and electrical characteristics.
6. Check V-belt drive for alignment.

GENERAL MAINTENANCE

CAUTION *–Before any maintenance or service is performed, be sure that unit is disconnected from power source to prevent accidental starting.*

Cast Aluminum & Metal Parts

The cast aluminum bearing housings and impellers, as well as all metal parts, are maintenance free and should not require any maintenance during the life of the unit.* In a severe dirty operation, the wheel should be cleaned with a wire brush to prevent an accumulation of foreign matter that could result in fan unbalance. After cleaning impeller, inspect for possible cracks or excessive wear, which can cause unbalance. Belts on V-belt drive units require periodic inspection and replacement when worn.

*Painted metal surfaces may require periodic repainting.

Motor Maintenance

1. Removing dust and dirt: Blow out open type motor windings with low pressure air to remove dust or dirt. Air pressure above 50 P.S.I. should not be used as high pressure may damage insulation and blow dirt under loosened tape. Dust can cause excessive insulation temperatures.
2. Lubrication: Under normal conditions, ball bearing motors will operate for five years without re-lubrication. Under continuous operation at higher temperatures (exceeding 104 degrees F. ambient) or dusty atmosphere re-lubricate after one year. To re-lubricate motor bearings, disassemble motor and housings thoroughly. Bearings are located in the end shields of the motor. Repack each bearing and fill cavity in back of bearings 1/3 full with Alvania Grease No. 2 (Shell Oil Company) or equivalent.

V-BELT DRIVES

CAUTION–*Care should be taken not to over tighten V-belt drives. Excessive belt tension overloads fan and motor bearings. It is much less expensive to replace belts worn from slippage than to replace bearings damaged from excessive loading.*

Fans shipped completely assembled have had V-belt drive aligned at Cincinnati Fan. Alignment should be re-checked before operation as a precaution due to handling during shipment.

1. Be sure sheaves are locked in position.
2. Key should be seated firmly in keyway.
3. Place straight edge or taut cord across faces of driving and driven sheaves to check alignment. The motor and fan shafts must be parallel; with V-belts at right angles to the shafts.
4. Start the fan. Check for proper rotation. Run fan at full speed. A slight bow should appear on slack side. Adjust belt tension by adjusting motor on its sliding base. All belts must have slack on one side.
5. If belts squeal at start-up, they are too loose and should be tightened.
6. When belts have had time to seat in the sheave grooves, then readjust belt tension.

V-belt drive assembly can be mounted as follows:

1. Clean motor and fan shafts. Be sure they are free from corrosive material. Clean bore of sheaves and coat with white lead or heavy oil for ease of shaft entry. Remove oil, grease, rust or burrs from sheaves.
2. Place fan sheave on fan shaft and motor sheave on its shaft. DO NOT POUND SHEAVES ON as this may damage bearings. Tighten sheaves in place.

3. Move motor on slide base so belts can be placed in grooves of both sheaves without forcing. Do not roll belts or use a tool to force belts over the grooves.
4. Align fan and motor shafts so they are parallel. The belts should be at right angles to the shafts. A straight edge or taut cord placed across the face of sheaves will aid in alignment.
5. Tighten belts by adjusting motor base. Correct tension gives the best drive efficiency. Excessive tension causes undue bearing pressure.
6. Start the fan and run it at full speed. Adjust belt tension until only a slight bow appears on the slack side of the belts. If slippage occurs, a squeal will be heard at start-up. Eliminate this squeal by tightening up the belts.
7. Give belts a few days running time to become seated in sheave grooves – then readjust belt tension.

If the shafts become scratched or marked, carefully remove sharp edges and high spots such as burrs with fine emery cloth or honing stone. Avoid getting emery dust in the bearings.

Do not apply any belt dressing unless it is recommended by the drive manufacturer. V-belts are designed for frictional contact between the grooves and sides of the belts. Dressing will reduce this friction.

Belt tension on an adjustable pitch drive is obtained by moving the motor – not by changing the pitch diameter of the adjustable sheave.

BEARING MAINTENANCE

Sealed Bearings

Sealed for life bearings are pre-lubricated with the correct amount of manufacturer-approved ball bearing grease, and are designed for application where re-lubrication is not required.

Units feature two single row deep groove bearings in a rugged cast aluminum or cast iron bearing bracket. Dirt and grease guard seals are an integral part of the assembly. For high temperature applications the bearings are pre-lubricated with a high temperature grease.

Relubricatable Bearing

For grease lubricated ball or roller bearings, or pillow blocks, a good grade of soda soap grease free from chemically or mechanically active material should be used.

This grease is a mixture of lubricating oil and a soap base to keep the oil in suspension. They have an upper temperature limit where the oil and soap base oxidize and thermally decompose into a gummy sludge.

Grease listed (or equivalents) are satisfactory for normal operating conditions. Regreasing will vary from 3 months to a year depending upon hours of operation, temperature and surrounding conditions. Special grease may be required for dirty or wet atmospheres (consult your lubricant supplier).

The pillow block should be filled with a low pressure gun until 1/3 full as excess grease may cause over heating.

Recommended grease for temperatures ranging from -40 degrees F to 250 degrees F are: Sinclair Refining Co.–AF No. 2, Scony Mobile Oil Co.–Mobilplex EP No. 1, Sun Oil Co.–Sun 72XMP grease, Esso Standard Oil Co.–ANDOK "C", Texas Co.–Texaco Regal Starfak No. 2.

WARRANTY

Cincinnati Fan & Ventilator Company warrants products of its own manufacture, against defects of material and workmanship under normal use and service for a period of eighteen (18) months from date of shipment or twelve (12) months from date of installation whichever occurs first. This warranty does not cover ordinary wear and tear, abuse, misuse, overloading, altered products, systems or materials not of Seller's manufacture. Expenses incurred by Buyer(s) in repairing or replacing any defective product will not be allowed except where authorized in writing and signed by an officer of the Seller.

The obligation of Seller under this warranty shall be limited to repairing or replacing F.O.B. Seller's plant, or allowing credit at Seller's option.

On equipment furnished by Seller, but manufactured by others, such as motors, Seller extends the same warranty as Seller receives from the manufacturer thereof.

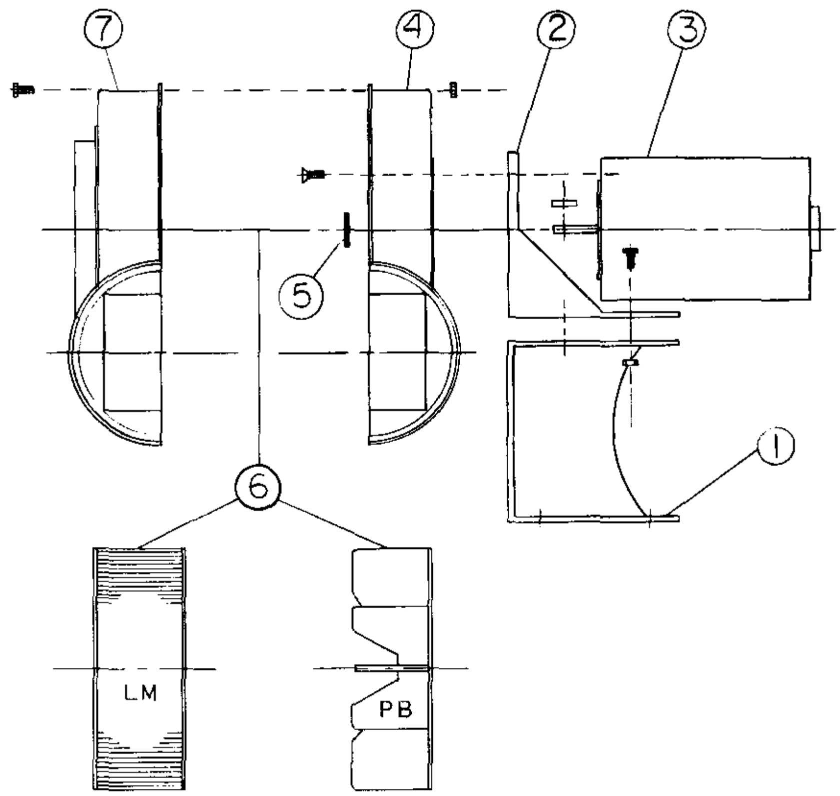
Cincinnati Fan & Ventilator Company assumes no responsibility for material returned to our plant without our written permission.

ORDERING REPLACEMENT PARTS

Replacement or spare parts may be ordered through your local Cincinnati representative.

The following information should accompany parts orders.

1. Motor horsepower, frame size and motor speed.
2. Fan Speed (if V-belt driven).
3. Fan arrangement and model number.
4. Serial number, model number and a complete description of the part.

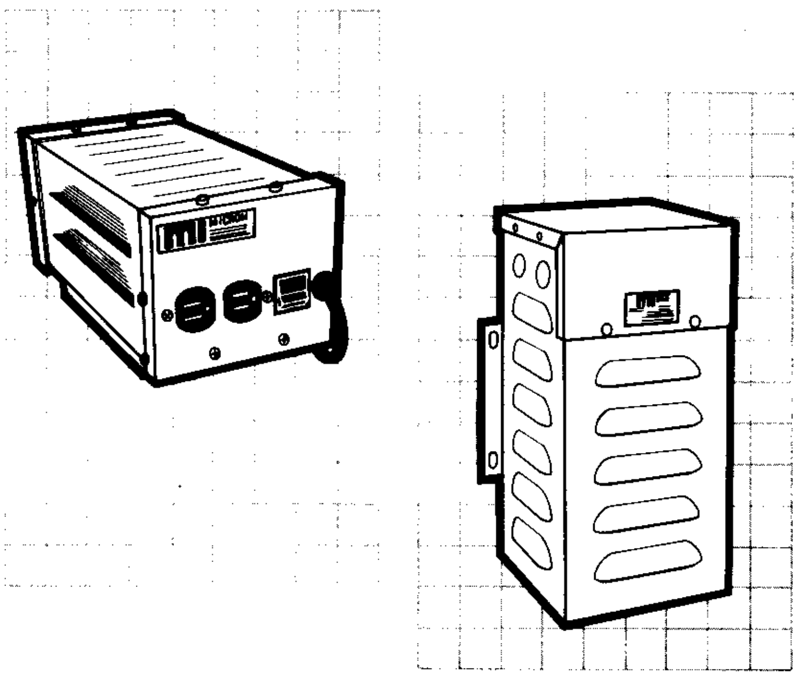


MODEL PB and LM
Arrangement No. 4

1. Base
2. Angle bracket (when required)
3. Motor
4. Housing, motor side
5. Felt seal (optional)
6. Wheel
7. Housing, inlet side

Micron *Power Conditioners*

Installation, operation and service



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MICRON INDUSTRIES CORPORATION

INSTALLATION, OPERATING AND SERVICE INSTRUCTIONS
FOR POWER CONDITIONERS
UL LISTED, CONTROL NUMBER 39L6

DESCRIPTION

Micron Power Conditioners perform four essential functions: 1) attenuate electrical noise contained in the input voltage source, 2) suppress transients, 3) maintain the output voltage to the load constant although the input voltage may fluctuate over a range of +10% to -20% of nominal, and 4) protect against overloads. This is defined as complete power line conditioning as it includes each of the four functions essential to protection of electronic equipment.

Micron Power Conditioners are of ferro-resonant magnetic design which provides excellent electrical isolation between line and load. They are designed to provide noise attenuation of 120 dB for common mode and 60 dB for transverse mode.

The power conditioner is for indoor use only and are intended for wall or floor mounting. A qualified electrician is required for installation.

MOUNTING

Power conditioners can be installed on either wall or floor where the unit weight and size will permit. The units are cooled by natural draft air circulation. Poorly ventilated spaces should be avoided and minimum spacing between two or more power conditioners should be four inches.

If the power conditioner is wall mounted, the wiring compartment should be mounted up. When mounting the power conditioner to a wall, the following minimum size steel bolts must be used in all mounting holes provided.

VA Size of Unit	Minimum Steel Bolt Size
750 and 1000	1/4 Inch Diameter Bolts
2000	5/16 Inch Diameter Bolts

Micron Power Conditioners are fully enclosed. Personnel are safe from accidental burns since the core is not exposed; personnel guards are not required.

FUSING

Micron Power Conditioners are designed with built-in current limitation which may allow the unit to operate under a direct short circuit load without damage. Fusing of the load is not necessary, however, the source side of the power conditioner may be fused. The fuse rating should be 1 1/2 times the rated operating current, except when connected to a rectified load. Then the fuse should be rated at five times nameplate current because of the high inrush current.

CONNECTIONS

Units should be hard wired to a branch circuit in accordance with local and national electrical codes. Power conditioners having output voltages rated 120/240 can operate at full nameplate rating of 120 volts, or 240 volts, or 120/240 volts, three-wire connection. For these power conditioners a load equal to the name plate VA rating of the power conditioner may be connected across 5 and 6 (or 6 and 7 for 120 volts), but the maximum load which can be connected across 5 and 6 and 6 and 7 must not each exceed 1/2 the VA rating of the power conditioner. The sum of all three-wire connected loads at the 120/240 volt rating must not exceed the nameplate VA rating.

PARALLEL WIRING

Micron Power Conditioners may be connected in parallel to increase load capacity to a level equal to the sum of the VA ratings of individual power conditioners. The individual units must be of the same type, VA capacity, voltage rating, and frequency.

THREE-PHRASE OPERATION

Three single-phase power conditioners may be banked and used for three-phase applications. The primaries of the power conditioners must be delta connected to the three-phase source. The secondaries must be WYE connected to the load. Three-phase loads should not be connected phase-to-phase: A to B, B to C, C to A.

Single-phase loads can be connected to the three-phase source. The loads can be balanced (equal load VA to each phase) or totally unbalanced. The load of each phase can not exceed one-third of the total VA of the power conditioners. The loads must be connected phase-to-neutral: A to N, B to N or C to N.

It is highly suggested that the neutral of the power conditioners secondaries and the neutral of the load be connected to a reliable ground. Figure 1 is a typical three-phase wiring diagram.

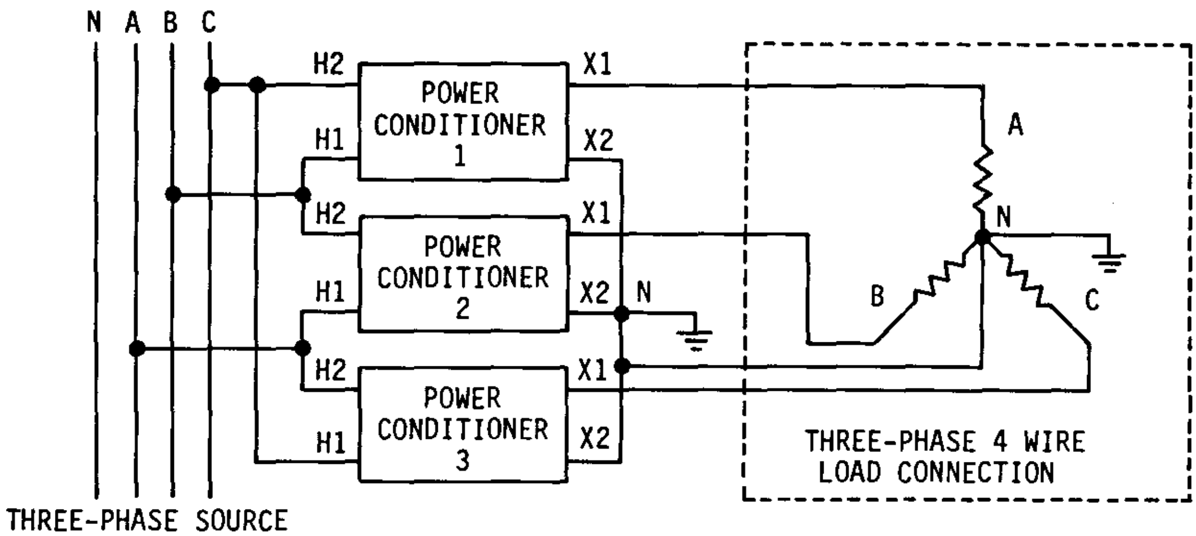


FIGURE 1. THREE-PHASE WIRING DIAGRAM

DERATING FOR WIDER INPUT VOLTAGE RANGE

Where conditions necessitate a greater low voltage input range than the rated range, a power conditioner can be oversized to achieve a lower input voltage range, while maintaining the rated output voltage. Table 1 sets forth the oversizing factor which will achieve a given lower input voltage, express as a percent below the nominal voltage rating of the unit.

TABLE 3. OVERSIZING FACTOR FOR LOWER INPUT VOLTAGE RANGE

INPUT VOLTAGE RANGE BELOW NOMINAL	OVERSIZE FACTOR
-20%	1.00
-30%	1.02
-40%	1.40
-50%	2.00
-60%	3.10

Formula: (1) Input Voltage Range Below Nominal = (Lowest Input ÷ Nominal Voltage) X -100

(2) Round answer of (1) to next largest percent shown in Table 1 and refer to corresponding Oversize Factor

(3) Required Nameplate VA = Oversize Factor X VA of load to be served.

SPECIFICATIONS AND DIMENSIONAL DATA

Power conditioner specifications and dimensional data are shown in Table 2. These specifications should be read in conjunction with dimension drawings (Figure 2), standard wiring connections (Table 3), and the wiring diagram (Figure 3).

TABLE 2. POWER CONDITIONERS, SINGLE PHASE, 60 Hz

VA	INPUT	OUTPUT	DIMENSIONS (Inches) A	B	C	D	E	F	MOUNTING SLOTS	APPROX. SHIP Wt.(Lbs)
750	95-130/ 190-260	120/240	16.25	8.75	5.63	8.13	6.00	9.00	0.38 X 0.75	32
1000	95-130/ 190-260	120/240	16.25	8.75	5.63	8.13	6.00	9.00	0.38 X 0.75	40
2000	95-130/ 190-260	120/240	20.13	10.75	5.13	11.25	6.31	12.25	0.44 X 0.88	60

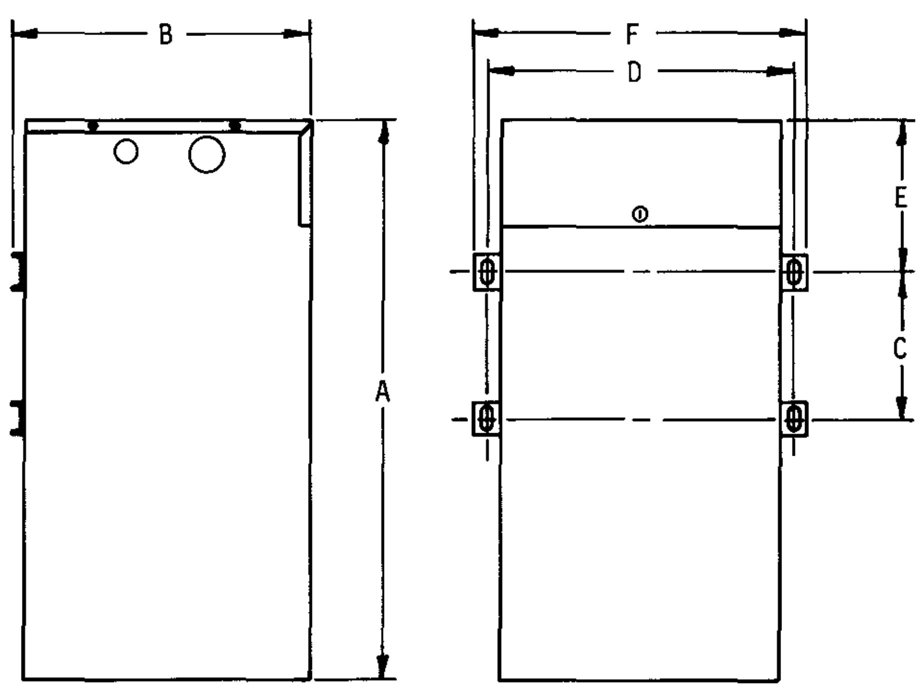


FIGURE 2. POWER CONDITIONER DIMENSIONAL DRAWINGS

TABLE 3. POWER CONDITIONERS STANDARD WIRING CONNECTIONS

INPUT CONNECTIONS			OUTPUT CONNECTIONS		
VOLTAGE (VAC)	POWER LINE CONNECTIONS	INTERNAL CONNECTIONS	VOLTAGE (VAC)	LOAD CONNECTIONS	CAPACITY
95-130	1 & 4	1 to 2 & 3 to 4	120	5&6 or 6&7	Rated VA
			240	5 & 7	Rated VA
190-260	1 & 4	2 to 3	120 120	5 & 8 5 & 6	1/2 Rated VA each
			120 240	5 & 6 5 & 7	1/2 Rated VA each

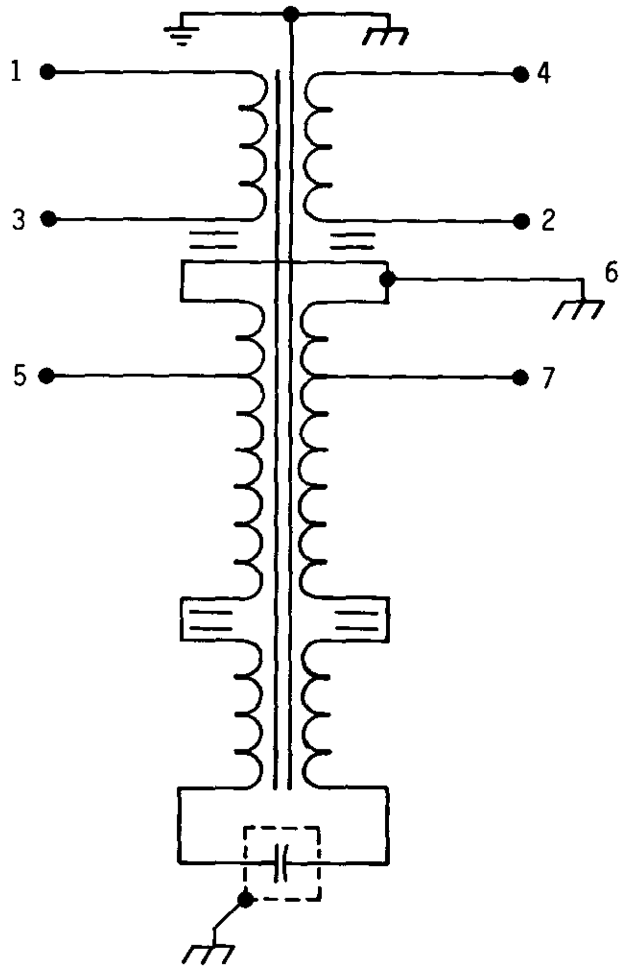


FIGURE 3. WIRING DIAGRAM

AUDIBLE NOISE

Micron Power Conditioners are designed and manufactured to minimize the level of noise. In normal operating environments the noise should not be noticeable. If desired, sound absorption materials may be externally used, provided ventilation to the unit is not impeded. It is suggested whenever possible large units for computer room applications be installed outside the room near the distribution panel.

OPERATING TEMPERATURES

Micron Power Conditioners are designed to operate in ambient temperatures found in typical plant, laboratory, retail, office, and home environments. In operation the temperature of the unit will rise whether or not the power conditioner is delivering to a load. The temperature rise can vary between 45°C to 100°C, depending upon type and rating of the power conditioner. The maximum temperature rise will always be within safe operating conditions for the temperature class of the insulation system used.

MOTOR LOADS

Because of the built-in current-limiting capability of the power conditioner, the nameplate load rating of the power conditioner must be nearly equal to the maximum power drawn during locked-rotor condition of the motor.

EFFECT OF FREQUENCY

Changes in frequency of the input voltage will change the level of output voltage to the load. Each 1.0% change in the frequency of the input voltage will result in approximately 1.8% change in output voltage in the same direction as the frequency change.

CURRENT LIMITATION

Each Micron Power Conditioner is rated to accommodate loads to a given value. If the load is increased beyond the rating of the power conditioner, a point is reached when the output voltage will collapse to near zero. For the power conditioner to regain its normal output voltage, the overload or short-circuit must be removed from the power conditioner. Under short-circuit conditions, the load is current-limited to approximately 150% of the rated full-load value at nominal input voltage. The power conditioner may remain in excessive load or short-circuit conditions without damage to the load or power conditioner. Fusing is not required.

RESPONSE TIME

Micron Power Conditioners provide near instantaneous response to line and load changes. Transient changes in supply voltage will normally return to its original level within 1 1/2 cycles. Fluctuation of the output voltage will remain within a few percent of its original level.

INPUT CHARACTERISTICS

The power conditioner transformer is energized whether it is serving or not serving a load. Input power factor will always be leading, and will average 90% to 100% at full load, around 75% at half load, and 25% at no load.

MAINTENANCE AND TROUBLESHOOTING

MAINTENANCE

Micron Power Conditioners have no moving parts, thus no regular maintenance is required.

REPLACEMENT CAPACITORS

Capacitors used in all power conditioners are of the highest commercial grade available. However, a limited number of capacitors may fail. During the warranty period, new capacitors will be provided without charge.

Replacement capacitors can be ordered through a Micron distributor or sales representative. When ordering replacement capacitors, provide the model number of the power conditioner and the capacitor part number.

TROUBLESHOOTING

Micron Power Conditioners are designed and manufactured to provide years of service. However, if poor performance is suspected, the following procedures may be used to check the power conditioner.

WARNING

WARNING

BECAUSE OF POSSIBLE EXPOSURE TO HIGH VOLTAGES INSIDE THE POWER CONDITIONER, TROUBLESHOOTING PROCEDURES MUST BE CARRIED OUT ONLY BY A QUALIFIED ELECTRICIAN.

1. NO OUTPUT VOLTAGE.
   - A. Assure the input(s) and output(s) ar properly connected.
   - B. Check power supply and input switch.
   - C. If fused, check fuse and fuse rating. (If the fuse rating is correct and it opens repeatedly, a capacitor or magnetic component may be shorted or grounded.)

2. NOMINAL OUTPUT VOLTAGE TOO LOW.
   - A. The load may have a lagging power factor.
   - B. Unit may be slightly over loaded.

3. NOMINAL OUTPUT VOLTAGE TOO HIGH.

   A. The load may have a leading power factor.
   B. If the load is substantially less than full rating of the unit, the voltage will be slightly high.

4. DOES NOT REGULATE TO SPECIFICATIONS.

   A. The unit may be slightly over loaded.
   B. With varying loads, a certain degree of load regulation may be mixed with the line voltage regulating action.
   C. Actual input voltage range may be outside the rated input range of the unit. This appears as more prevalent on the low side.

5. OUTPUT VOLTAGE EXTREMELY LOW (20 TO 60 VOLTS).

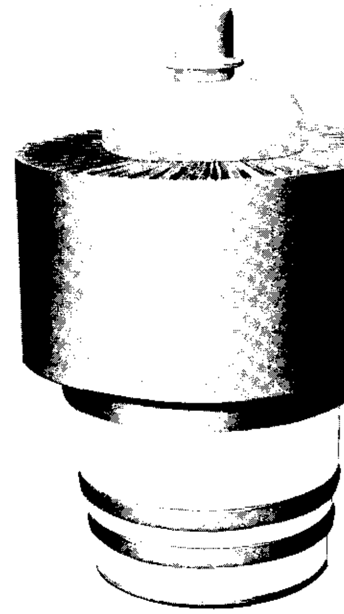
   A. One or more capacitors in the power conditioner may be defective.
   B. Unknown overloads of significant size occurring intermittently, such as, solenoid inrush currents and motor starting currents.

Warranty

MICRON *Power Conditioners* are warranted against defects in workmanship or material for a period of two years from date of sale.

TECHNICAL DATA

4CX7500A
VHF
RADIAL BEAM
POWER TETRODE



The EIMAC 4CX7500A is a compact ceramic/metal radial beam power tetrode intended for use in VHF power amplifier applications. It features a type of internal mechanical structure which results in high rf operating efficiency. Low rf losses in this structure permit operation at full ratings to 220 MHz. A dense mesh filament is used which contributes to the high performance capability.

The 4CX7500A has a gain of over 20 dB in FM broadcast service, and is also recommended for rf linear power amplifier service and for VHF-TV linear amplifier service. The anode is rated for 7500 watts of dissipation with forced-air cooling.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh		
Voltage	7.0 ± 0.35	V
Current, at 7.0 volts	110	A
Amplification Factor, average		
Grid to Screen	4.5	
Direct Interelectrode Capacitances (cathode grounded)[2]		
Cin	145	pF
Cout	20	pF
Cgp	0.5	pF
Direct Interelectrode Capacitances (grids grounded)[2]		
Cin	74.1	pF
Cout	20.6	pF
Cpk	0.065	pF
Maximum Frequency for Full Ratings (CW)	220	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	8.72 In; 21.5 cm
Diameter	5.66 In; 14.4 cm
Net Weight (approximate)	7.7 Lbs; 3.5 kg
Operating Position	Axis Vertical, Base Up or Down
Cooling	Forced Air
Maximum Operating Temperature, Ceramic/Metal Seals & Anode Core	250°C
Base	Special, Coaxial
Recommended Air-System Socket	HF: EIMAC SK-340
	VHF: EIMAC SK-350
Available Screen Grid Bypass Capacitor Kit for SK-350 or SK-360 (8000 pF @ 5000 DCWV)	EIMAC-SK-355
Recommended Air-System Chimney (for SK-350 or SK-360)	EIMAC SK-346
Recommended EIMAC Cavity Assembly for FM Broadcast Service	CV-2228
Available Anode Connector Clip	EIMAC ACC-3

RADIO FREQUENCY POWER AMPLIFIER
Class C Telegraphy or FM
(Key-down Conditions)

ABSOLUTE MAXIMUM CONDITIONS

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	3.0	AMPERES
PLATE DISSIPATION	7500	WATTS
SCREEN DISSIPATION	165	WATTS
GRID DISSIPATION	50	WATTS

TYPICAL OPERATION
(Measured data in EIMAC CV2228 FM cavity at 100.5 MHz)

Plate Voltage	6.5	6.5	6.5	kVdc
Screen Voltage	635	750	750	Vdc
Grid Voltage	-460	-275	-400	Vdc
Plate Current	2.1	2.2	2.4	Adc
Screen Current	195	128	140	mAdc
Grid Current	185	90	95	mAdc
Driving Power	247	100	130	W
Efficiency	79.3	77.6	77.0	%
Useful Output Power	10.8	11.1	12.1	kW
Power Gain	16	20	19.7	dB

394625(Effective April 1985)
VA4807

Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER
Class AB1

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE . . .	7500	VOLTS
DC SCREEN VOLTAGE . .	1500	VOLTS
DC GRID VOLTAGE . . .	-500	VOLTS
DC PLATE CURRENT . . .	3.0	AMPERES
PLATE DISSIPATION . .	7500	WATTS
SCREEN DISSIPATION . .	165	WATTS
GRID DISSIPATION . . .	50	WATTS

Typical Operation, Peak Envelope or Modulation Crest Conditions (frequencies below 30 MHz)

Plate Voltage	7500	Vdc
Zero Signal Plate Current	750	mAdc
Max.Signal Plate Current	2.2	Adc
Screen Voltage	1250	Vdc
Screen Current *	95	mAdc
Grid Bias Voltage **	-190	Vdc
Grid Current *	0	mAdc
Useful Power Out # ##	10	kW
Driving Power *	0	W
Intermodulation Distortion Products §		
3rd Order Products	-32	dB
5th Order Products	-44	dB

* Approximate Value
** Adjust to specified zero-signal plate current
\# PEP output or rf power at crest of modulation envelope
§ Referenced against one tone of a two equal-tone signal

\## Delivered to the load

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in ouput power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

APPLICATION

MECHANICAL

MOUNTING - The 4CX7500A must be mounted with its axis vertical, base up or down at the convenience of the equipment designer, and should be protected from shock and vibration which could damage the internal structure of the tube.

AIR-SYSTEM SOCKET & CHIMNEY - The EIMAC sockets type SK-340 and SK-350 are designed especially for the concentric base terminals of the 4CX7500A. The SK-340 is intended for use at HF, while the SK-350 is recommended for VHF applications. The SK-346 chimney is intended for use with the either. Use of the recommended air flow rates through either socket will provide effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through the chimney and into the anode cooling fins.

COOLING - Forced-air cooling is required in all applications. The blower selected in a given application must be capable of supplying the desired air flow at a back pressure sufficient for the tube, plus any drop caused by ducts and filters. Air flow must be applied before or simultaneously with the application of power, including the filament, and may be removed simultaneously with filament voltage.
Minimum air flow requirements for a maximum anode temperature of 225°C for various altitudes and dissipation levels are listed. The pressure drop values shown are approximate and are for the SK-340/tube/SK-346 combination. If an SK-350 is used air passages in addition to those in the socket may be required for low pressure drop.

Inlet Air Temperature = 25°C

Altitude	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
Sea Level	5000	192	1.0
	7500	414	4.3
5000 Feet	5000	232	1.2
	7500	501	5.1
10,000 Feet	5000	281	1.4
	7500	607	6.1

Inlet Air Temperature = 35°C

Altitude	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
Sea Level	5000	220	1.25
	7500	476	5.42
5000 Feet	5000	268	1.5
	7500	576	6.5

10,000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	5000	324	1.75
	7500	698	7.75

Inlet Air Temperature = 50°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	5000	280	1.8
	7500	592	7.9

5000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	5000	332	2.1
	7500	717	9.4

10,000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	5000	402	2.5
	7500	868	11.3

With operation at plate dissipation below 5.0 kW and lower air flow inherent with that operation, special attention is required for cooling the center of the stem (base), by means of special directors or some other provision. Temperature measurements in this area should be made, as well as the anode seal areas, during development of the equipment. Temperature-sensitive paints are available for this purpose, and Application Bulletin #20 titled TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES is available from EIMAC on request.
An air interlock system should be incorporated in the design to automatically remove all voltages from the tube in case of even a partial failure of the tube cooling air.
It is considered good engineering practice to supply more than the minimum required cooling air, to allow for variables such as dirty air filters, rf seal heating, and dirty anode cooling fins if the tube has been in service for some time.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. <u>It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously</u>.

FILAMENT OPERATION - At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The filament voltage should then be increased a few tenths of a volt above the value where performance degradation was noted. The operating point should be rechecked after 24 hours. Filament voltage should be closely regulated when voltage is to be reduced in this manner, to avoid any adverse influence by normal line voltage variations. Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. Periodically the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best life.

GRID OPERATION - The maximum control grid dissipation is 50 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 165 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

SCREEN CURRENT - The screen current may reverse under certain conditions and produce negative indications on the screen current meter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind, so that the correct operating voltage will be maintained on the screen under all conditions. A current path from the screen to cathode must be provided by a bleeder resistor or a shunt regulator connected between screen and cathode and arranged to pass approximately 10% of the average screen current per connected tube. A series regulated power supply can be used only when an adequate bleeder resistor is provided.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and air-flow interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each tube anode, to absorb power supply stored energy if an internal arc should occur. EIMAC's Application Bulletin #17 titled FAULT PROTECTION contains considerable detail, and is available on request.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown here are taken in accordance with Standard RS-191. The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal appliction. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; Attn: Product Manager; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

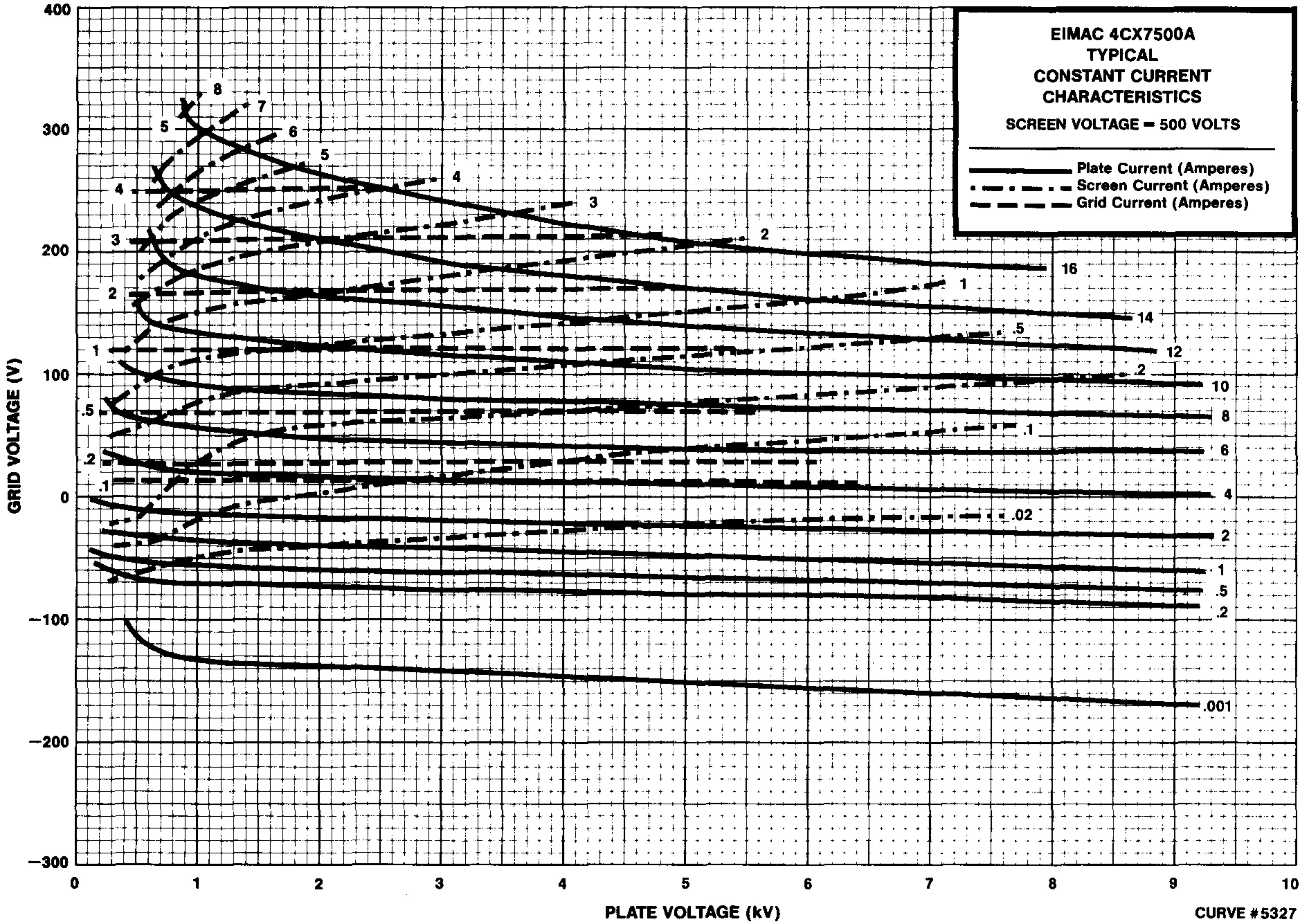
a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

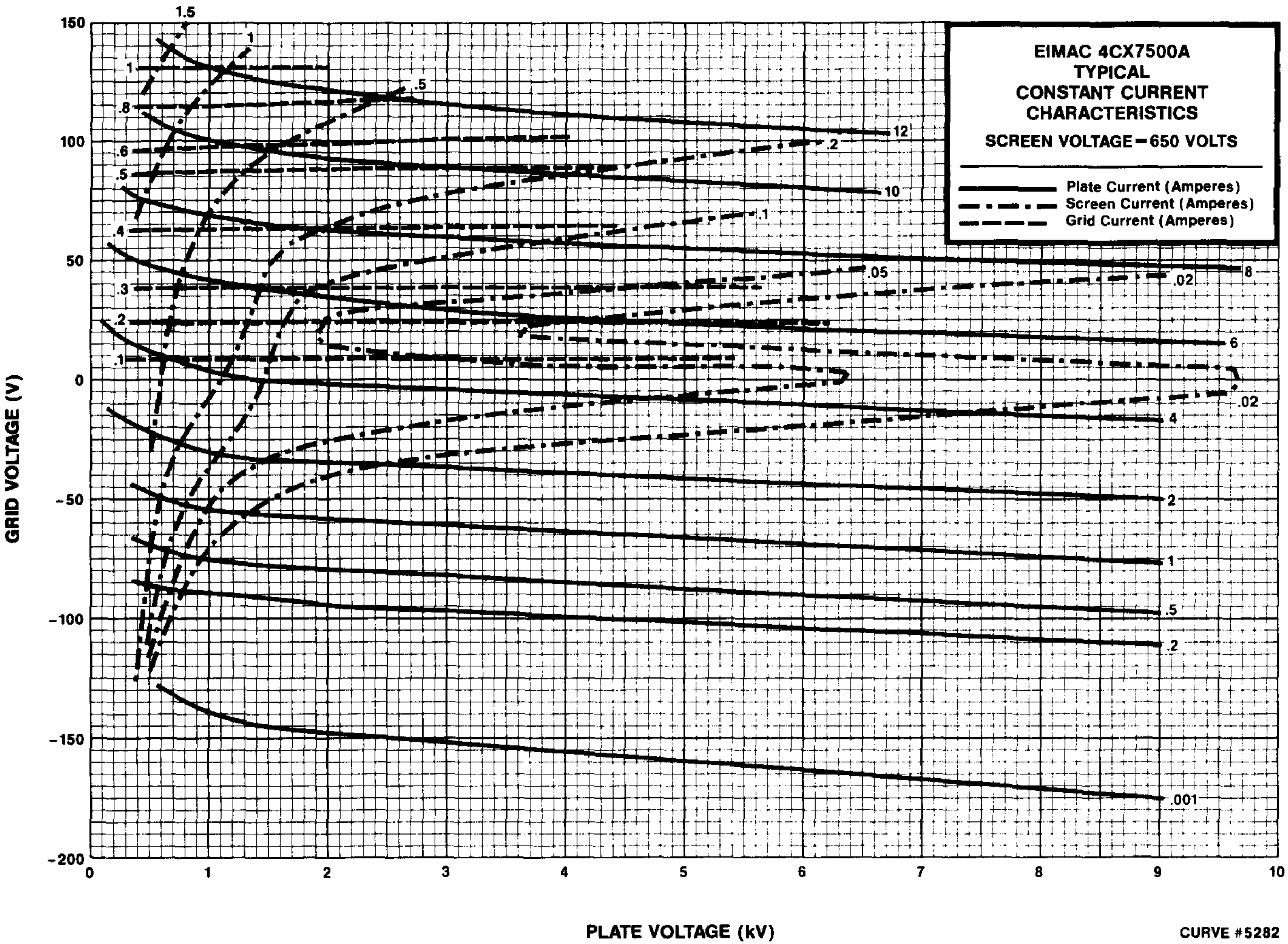
c. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

d. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

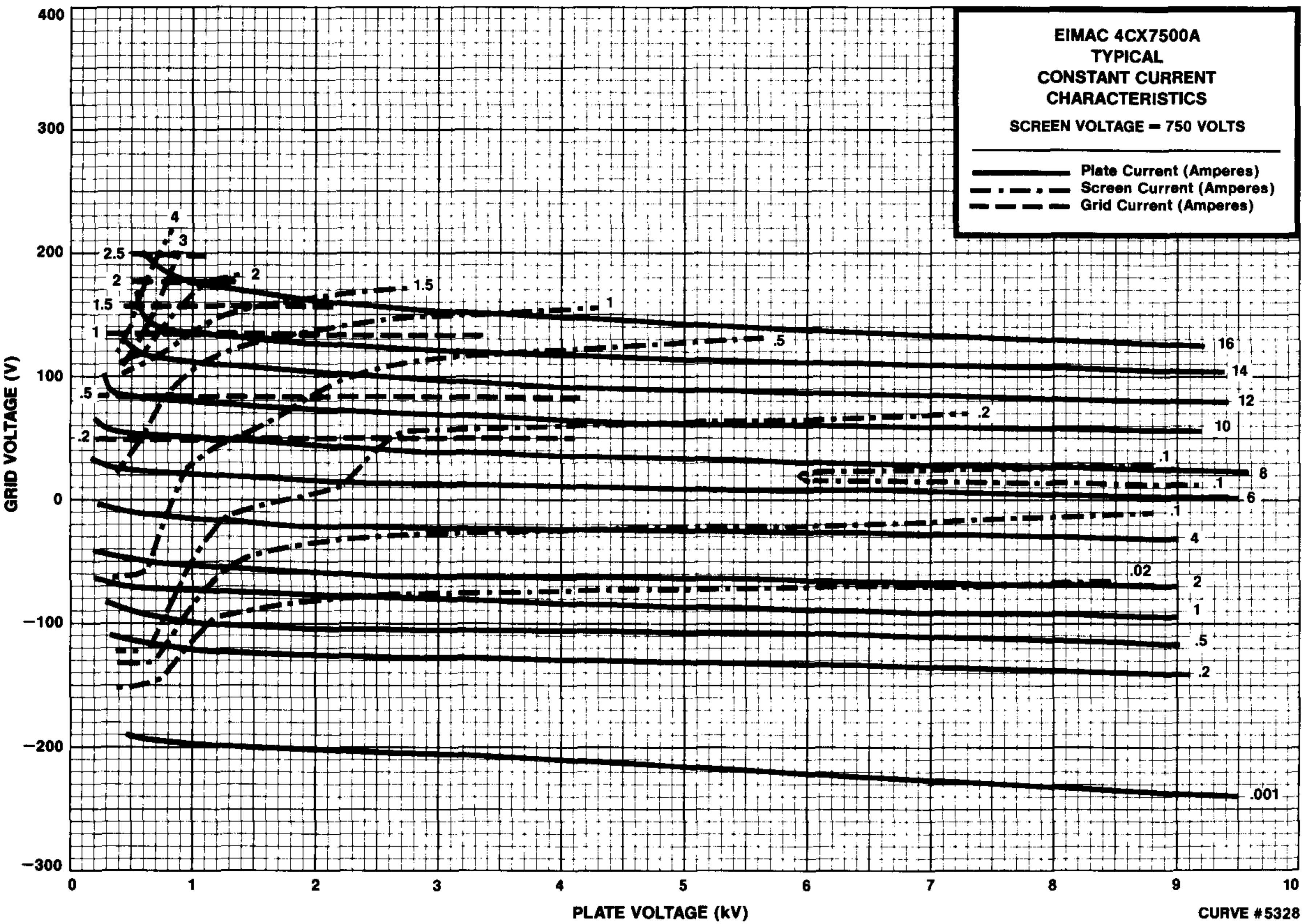
Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.


EIMAC 4CX7500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
400
300
200
100
0
−100
−200
−300
0
1
2
3
4
5
6
7
8
9
10
16
14
12
10
8
6
4
2
1
.5
.2
.001
.02
.1
CURVE #5327

4CX7500A

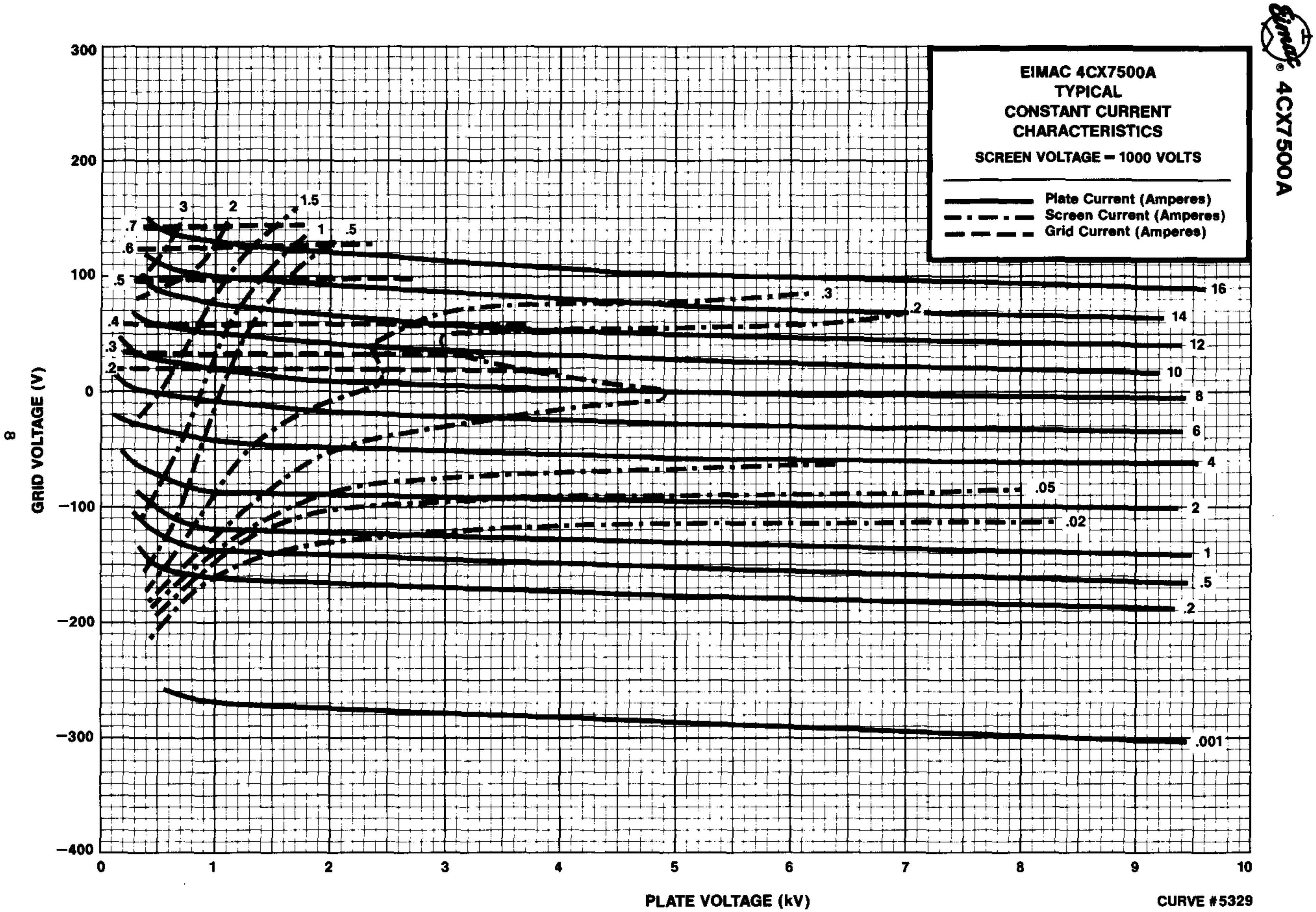

EIMAC 4CX7500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 650 VOLTS
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
150
100
50
0
-50
-100
-150
-200
0
1
2
3
4
5
6
7
8
9
10
12
10
8
6
4
2
1
.5
.2
.001
1.5
1
.5
.2
.1
.05
.02
.02
.8
.6
.5
.4
.3
.2
.1

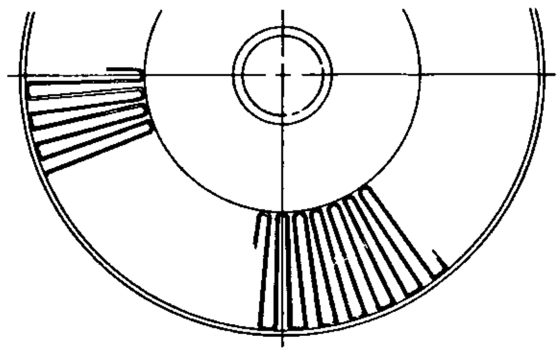
CURVE #5282



CURVE #5328

4CX7500A


EIMAC 4CX7500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1000 VOLTS
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #5329
4CX7500A



DIMENSIONAL DATA						
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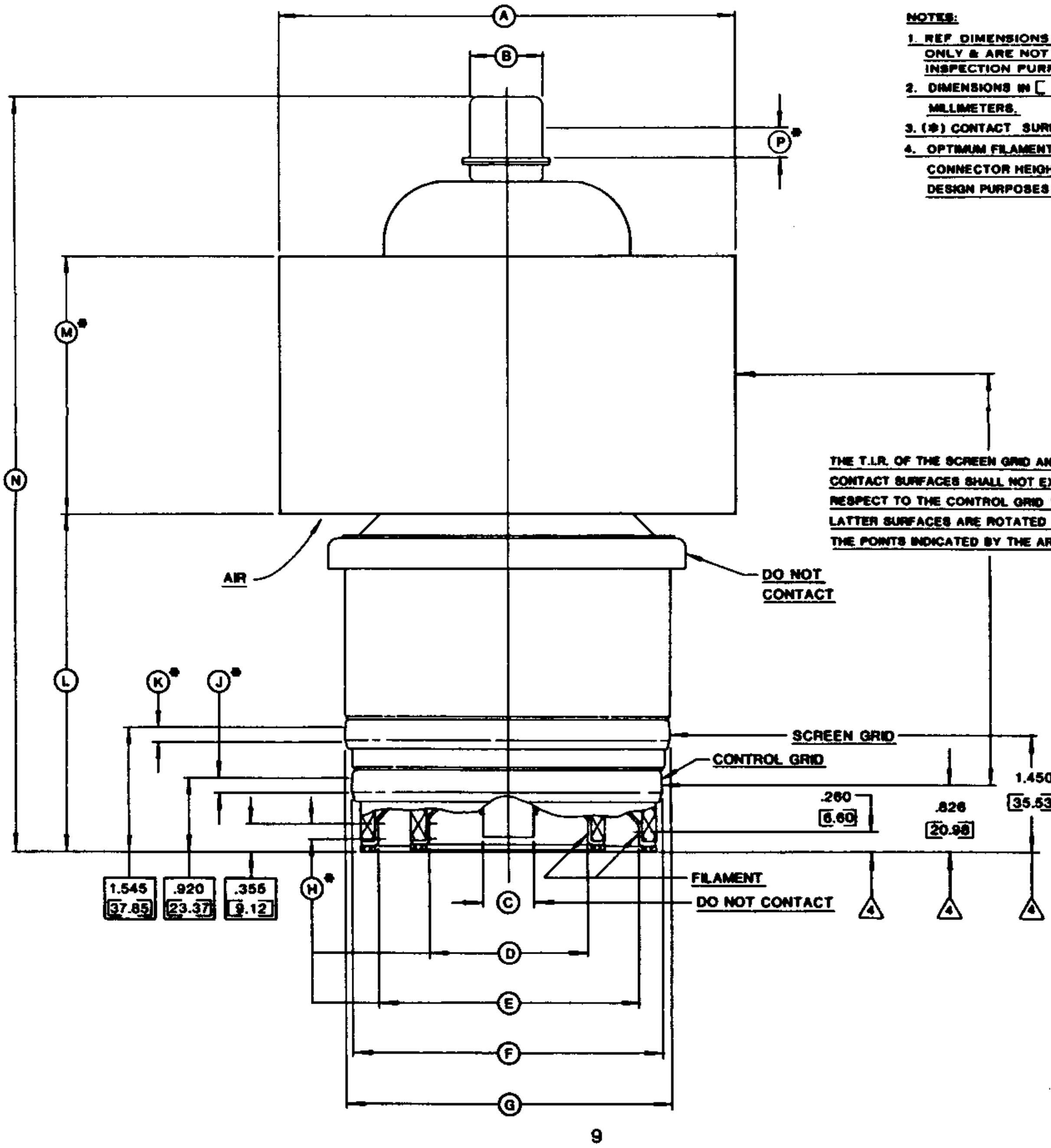
B	.855	.895		21.72	22.73	
C	.600	.760		15.24	19.30	
D	1.896	1.936		48.16	49.17	
E	3.133	3.173		79.58	80.59	
F	3.792	3.832		96.32	97.32	
G	3.980	4.020		101.09	102.11	
H	.188			4.78		
J	.188			4.78		
K	.188			4.78		
L	3.863	4.210		97.43	106.93	
M	2.812	3.187		71.42	80.95	
N	8.469	9.719		215.11	246.86	
P	.375			9.53		
R						
S						
T						
U						
V						
W						
Y						

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. DIMENSIONS IN [ ] ARE MILLIMETERS.
3. (*) CONTACT SURFACE.
4. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES.



EXTENDING TRANSMITTER TUBE LIFE

By Robert Artigo

A carefully followed program of filament voltage management can substantially increase the life expectancy of transmitter power grid tubes. With today's rising operating costs, such a program makes good financial sense.

IN RECENT YEARS station managers have seen a substantial increase in replacement costs for power grid tubes. The blame can be placed on higher manufacturing costs due to inflation, volatile precious metal prices, and an uncertain supply of some exotic metals. The current outlook for the future holds little promise for a reversal in this trend toward higher prices.

One way to offset higher operating costs is to prolong tube life. For years station engineers have used various tricks to get longer operating life, with greater and lesser degrees of success. Success can be maximized, however, by understanding the various

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EIMAC Application Bulletin AB-18
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March, 1982

factors that affect tube life and implementing a program of filament voltage management.

A number of factors can aid maximum tube life in your transmitter. For example, are the maximum ratings given on the tube manufacturer's data sheet being exceeded? Data sheets are available upon request from most companies. Most tube manufacturers have an application engineering department to assist in evaluating tube performance for a given application. Make use of these services!

Headroom

Is the final power tube of the transmitter capable of delivering power in excess of the desired operating level? Or is the demand for performance so great that minimum output power levels can only be met at rated nominal filament voltage?

Figure 1 can be used as a basic guide to determine if a given transmitter and tube combination has a good probability of giving extended life service. Extended life service is defined as useful operating life beyond that normally achieved by operating at rated nominal filament voltage. The amperes/watt ratio is obtained by dividing average plate current by the product of filament voltage and filament current. If the amperes/watt ratio falls in the "good" to "excellent" range, excess emission is sufficient to permit filament voltage derating. At a lower filament voltage, the filament temperature is lowered, thus extending life. A typical FM transmitter on the market today may have an amperes/watt filament ratio of 0.002 to 0.003. This equipment would be considered an excellent choice to achieve extended tube life. On the other hand, if the amperes/watt ratio falls in the "poor" range, it is unlikely that filament derating is possible due to limited emission. Note that this guideline should be used for thoriated tungsten emitters only, and does not apply to oxide cathode-type tubes.

Instrumentation

Are all tube elements metered in the transmitter? Elements should be metered for both voltage and current, and meters should be redlined to define operation within safe limits. More modern transmitters may incorporate a microprocessor-controlled circuit to monitor all pertinent parameters.

In addition, the following controls are necessary if an effective filament voltage management program is to be undertaken: power output metering for an FM transmitter or a distortion level meter for AM equipment; *accurate* filament voltage metering (an iron-vane instrument is preferred over the more common average responding RMS calibrated type; the filament voltage measurement must be made at the tube socket terminals); filament voltage control, capable of being adjusted to 0.1 V secondary voltage change; and a filament current meter—desirable but optional.

A means must be provided to hold filament voltage constant. If the filament voltage is permitted to vary in accordance with primary line voltage fluctuation, the effect on tube life can be devastating. An acceptable solution is the use of a ferroresonant transformer or line regulator. This accessory is offered by some transmitter manufacturers as an option and should be seriously considered if a tube life extension program is planned.

Transmitter housekeeping

Once the transmitter has been place in operation, tube life is in the hands of the chief engineer. The first action to prolong tube life falls into the category of routine maintenance. Most transmitter manufac-

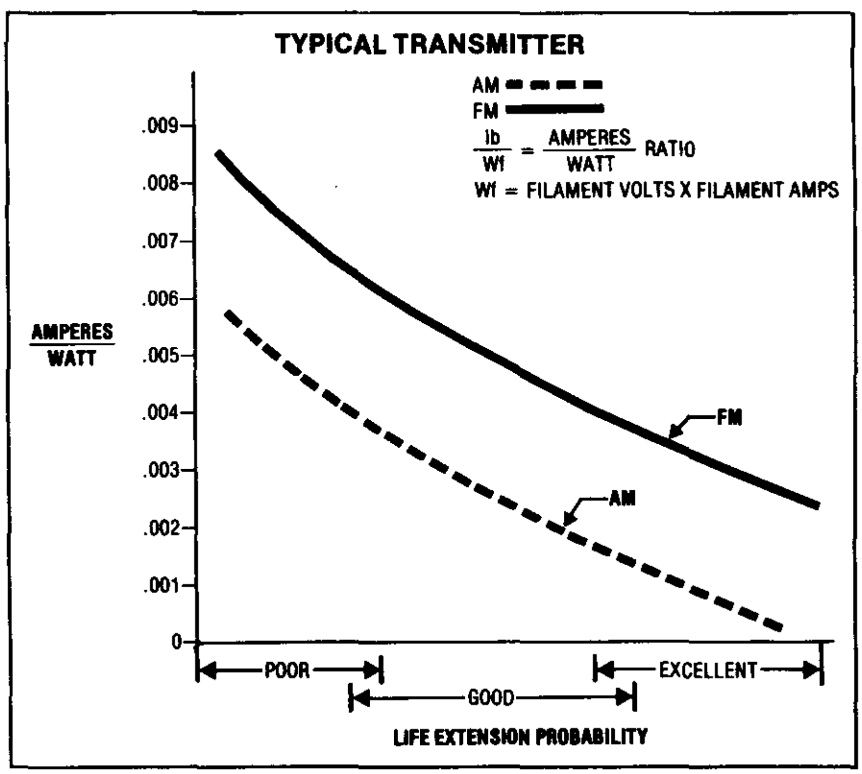


***Fig. 1.** Probability of extended life service can be determined from this graph. Divide the average p.a. plate current in amperes by the product of filament voltage and current. The resulting amperes/watt ratio (Y-axis) is projected horizontally to the appropriate curve. The vertical projection to the X-axis indicate the life extension probability.*

Extending Transmitter Tube Life

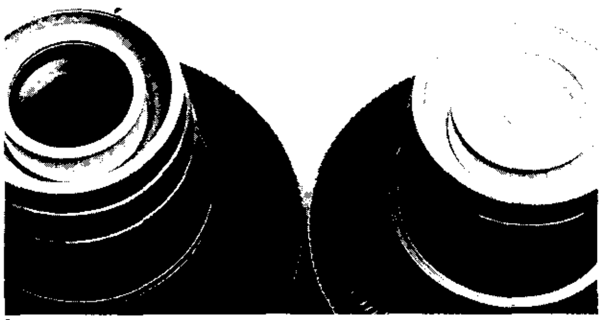


Figure 2

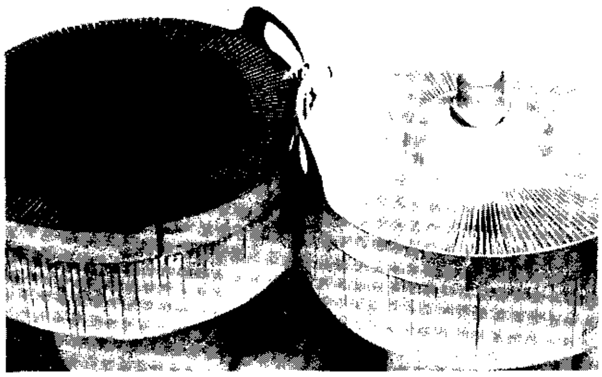


Figure 3

Figure 4

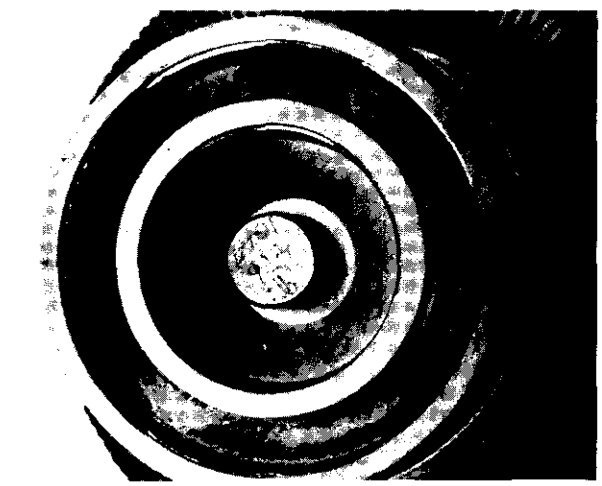


Figure 5

turers have a routine maintenance schedule established in the equipment manual. This procedure must be followed carefully if operating costs are to be held to a minimum. During routine maintenance it is very important to look for tube and socket discoloration, either of which can indicate overheating.

Look for discoloration around the top of the cooler near the anode core and at the bottom of the tube stem where the filament contacts are made. Review Figures 2 and 3 for examples of a tube operating with inadequate cooling. It is possible for discoloration to appear in the areas mentioned if the transmitter has to operate in a dirty environment. If this is the case, the tube should be removed and cleaned with a mild detergent. After cleaning, the tube should be rinsed thoroughly to remove any detergent residue and blown dry with compressed air. If the discoloration remains, this is an indication that the tube has operated at too high a temperature. Check inlet and outlet air ducting and filters for possible air restriction. It may also be necessary to verify that the air blower is large enough to do the job in the present environment and that it is operating at rated capacity.

With the tube removed, the socket should be blown or wiped clean and carefully inspected. Any discoloration in the socket finger stock caused by overheating could contribute to early tube failure. A finger stock that loses its temper through prolonged operation at high temperature will no longer make contact to the tube elements (Figure 4). A well-maintained socket will score the tube contacts when the tube is inserted. If all fingers are not making contact, more currect flows through fewer contacting fingers, causing additional overheating and possible burnout (Figure 5).

Filament voltage management

The useful operating life of a thoriated tungsten emitter can vary widely with filament voltage. Figure 6 describes the relative life expectancy with various filament voltage levels. Obviously, a well-managed filament voltage program will result in longer life expectancy. Improper management, on the other hand, can be very costly.

For a better understanding of this sensitive aging mechanism, the filament itself must be understood. Most filaments in high-power, gridded tubes are a mixture of tungsten and thoria with a chemical com-

Fig. 2. *Improper cooling means short tube life (left). Discoloration of metal around inner filament stem and anode fins indicates poor cooling or improper operation of tube. Properly cooled and operated tube (right) shows no discoloration after many hours of use. In both cases, good socketing is indicated by scoring on circular connector rings.*

Fig. 3. *Dirty and discolored cooler of amplifier tube at left indicates combination of discoloration due to heating and lack of cleaning. Tube has operated too hot and dust has collected in anode louvres.*

Fig. 4. *Minute scoring in base contact rings indicates that socket finger stock has made good, low-resistance contact to tube elements. Well-maintained socket will score the tube contacts when tube is inserted. If all fingers do not make contact, more current will flow through fewer contact fingers, causing additional overheating and burning, as shown in Fig. 5.*

Fig. 5. *High resistance socket contacts has caused severe burning of contact area in the base. Overheated base caused early demise of tube.*

position of W + THO_2. A filament made of this wire is not a suitable electron emitter for extended life applications until it is processed. Once the filament is formed into the desired shape and mounted, it is heated to approximately 2100°C in the presence of a hydrocarbon. The resulting thermochemical reaction forms di-tungsten carbide on the filament's surface. Life is proportional to the degree of carburization. If the filament is overcarburized, however, it will be brittle and easily broken during handling and transporting. Therefore, only approximately 25% of the cross-sectional area of the wire is converted to di-tungsten carbide. Di-tungsten carbide has a higher resistance than tungsten; thus, the reaction can be carefully monitored by observing the reduction in filament current as the carburizing process proceeds.

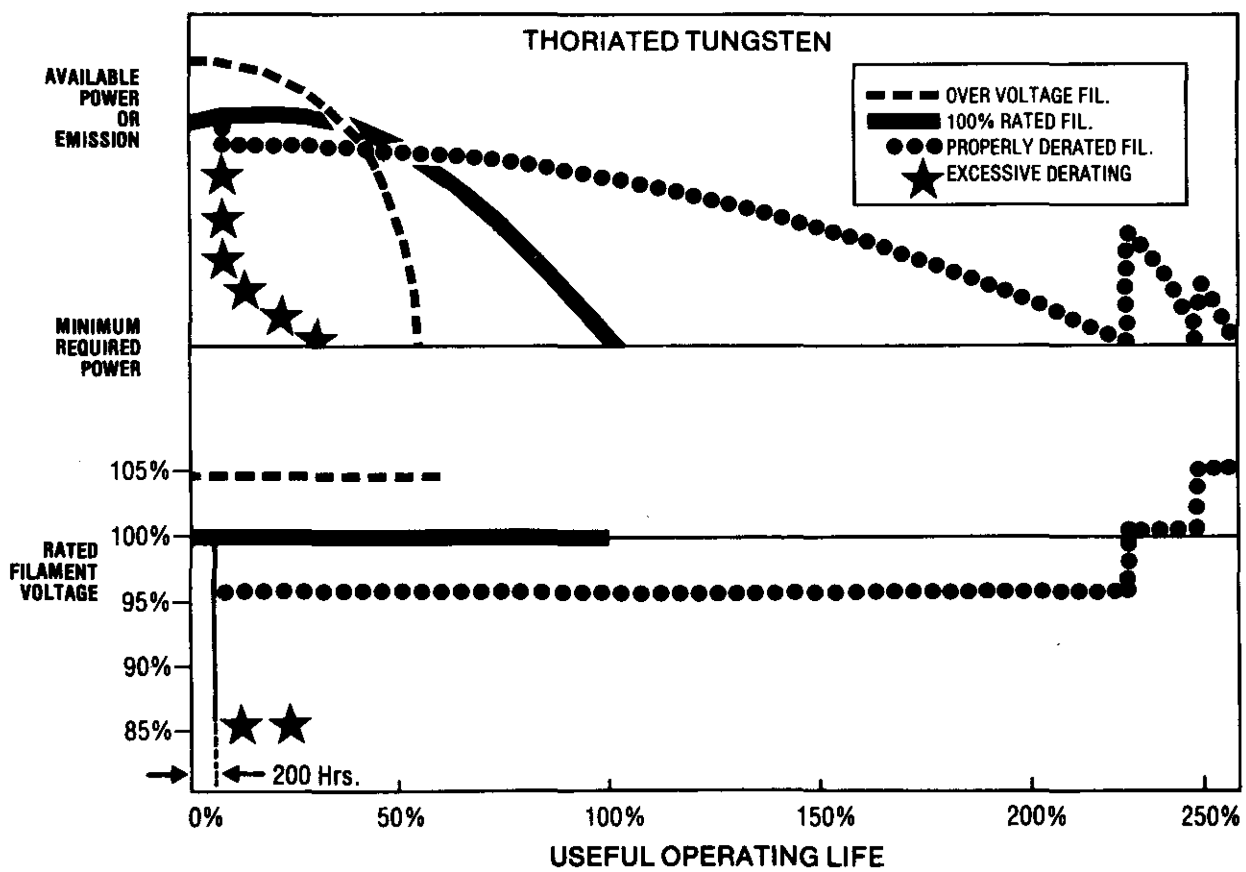
As the tube is used the filament slowly decarburizes. At some point in life, all of the di-tungsten carbide layer is depleted and the reduction of thoria to free thorium stops. The filament is now decarburized and is no longer an effective electron emitter.

The key to extending the life of a thoriated tungsten filament emitter is to control operating temperature. Emitter temperature is a function of the total RMS power applied to the filament. Thus, filament voltage control is temperature control. Temperature varies directly with voltage. As the emitter temperature rises the de-carburizing process is accelerated and tube life shortened. Figure 6 shows that useful tube life can vary significantly with only a 5% change in filament voltage. *If the filament voltage cannot be regulated to within ±3%, the filament should always be operated at the rated nominal voltage.* The danger of operating on the "cold" temperature side is that the emitter may be "poisoned." A cold filament acts as a getter; that is, it attracts contaminants. When a contaminant becomes attached to the surface of the emitter, that area is rendered inactive and loss of emission results. Operation of the filament at slightly below rated nominal voltage, however, can extend tube life if done properly.

FILAMENT VOLTAGE MANAGEMENT (Figure 6)

Filament voltage management allows extended tube life when accompanied by a continuing housekeeping program. When filament voltage is too high (dashes), power tube looses emission rapidly and normal operating life is not achieved. When filament is operated at rated voltage (black curve) normal tube life is achieved in a majority of cases. With a filament voltage management program (bullets), extended tube life may be achieved. When the minimum required output power level is finally reached (right-hand portion of curve), the filament voltage may be raised to rated value, or above, to achieve additional useful operating life. If filament is run "cool" (stars), extremely short life will result. Note that filament voltage management program does not take effect until about 200 hours of operating time have passed.

If voltage management program is not undertaken, tube should be run at rated filament voltage.



Extending Transmitter Tube Life

Of great importance to long tube life is the temperature of the elements and the ceramic-to-metal seals. Element temperature can be held within proper limits by observing the maximum dissipation ratings listed in the data sheet. Seal temperature should be limited to 200°C at the lower anode seal under worst-case conditions. As element temperature rises beyond 200°C, the release of contaminants locked in the materials used in tube manufacturing increases rapidly. These contaminants cause a rapid depletion of the di-tungsten carbide layer of the filament.

When a new power tube is installed in a transmitter, it must be operated at rated nominal filament voltage for the first 200 hours. This procedure is very important for two reasons. First, operation at normal temperature allows the getter to be more effective during the early period of tube life when contaminants are more prevalent. This break-in period conditions the tube for operation at lower filament voltage to obtain longer filament life. Secondly, during the first 200 hours of operation filament emission increases. It is necessary for the life extension program to start at the peak emission point.

A chart recorder or other device should be used to monitor variations in primary line voltage for several days of transmitter operation. The history of line voltage variations during on-air time must be reviewed prior to derating filament voltage. Plan to establish the derated voltage during the time period of historically low line voltage, as this is the worst-case condition. If line variation is greater that ±3%, filament voltage must be regulated.

Record output power (FM) or distortion level (AM) with the tube operating at rated nominal filament voltage. Next, reduce filament voltage in increments of 0.1 V and record power or distortion levels at each increment. Allow one minute between each increment for the filament emission to stabilize.

When a noticeable change occurs in output power or the distortion level changes, the derating procedure must stop. Obviously, operation at this point is unwise since there is no margin for a drop in line voltage. It is safer to raise the voltage 0.2 V above the critical voltage at which changes are observed to occur. If this new filament voltage setting is more than 5% below the nominal rated level, filament voltage must be raised to the 95% level. Operation below this point is unpredictable and life expectancy is uncertain. Finally, recheck power output or distortion to see if they are acceptable at the chosen filament voltage level. Recheck again after 24 hours to determine if emission is stable and that the desired performance is maintained. If performance is not repeatable, the derating procedure must be repeated.

Continuing the program

The filament voltage should be held at the properly derated level as long as minimum power or maximum distortion requirements are met. Filament voltage can be raised to reestablish minimum requirements as necessary. This procedure will yield results similar to those shown in the illustration, to achieve as much as 10% to 15% additional life extension. When it becomes necessary to increase filament voltage, it is a good time to order a new tube. Filament voltage can be increased as long as the increase results in maintaining minimum level requirements.

When an increase fails to result in meeting a level requirement, filament emission must be considered inadequate and the tube should be replaced. Don't discard it or sell it for scrap! Put it on the shelf and save it. It will serve as a good emergency spare and may come in very handy some day. Also, in AM transmitters, a low-emission RF amplifier tube can be shifted to modulator use where the peak filament emission requirement is not as severe.

Start planning for longer tube life now! Review the following steps you can take:

- Investigate the manufacturer's ratings on the power tubes in your present equipment, or the transmitter you plan to buy.
- Check that your transmitter has sufficient headroom. Is there a margin of safety in tube operation?
- Look for important instrumentation in the next transmitter you buy. Are all tube elements monitored for voltage and current in the transmitter?
- Whether your transmitter is new or old, start a filament life extension program.

Remember that each time you replace a power tube, the recommended derating procedure must be rerun. Voltage levels required with one tube do not apply to a replacement tube.

When purchasing a tube, insist on a new tube that carries the full, original manufacturer's warranty. Only tubes manufactured by the company of origin have to perform to published data. This is the important reason that transmitter manufacturers buy new, warranted tubes from the original manufacturer. **BM/E**

Thanks to William Barkley, William Orr, William Sain, and Bob Tornoe, all of Varian EIMAC, for their help and suggestions in preparing this paper.

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THOMSON-CSF

DIVISION SEMICONDUCTEURS DISCRETS

SD 1460

VHF NPN POWER TRANSISTOR FOR CLASS C FM OPERATION

FEATURES

- Gold metallizations
- Glass passivated structure → high reliability
- Hermetical ceramic package
- Emitter ballast resistors → severe inpedance mismatch
- Auto-aligned structure → high characteristics reproductibility

APPLICATIONS

Telecommunications up to 108 MHz frequency band.

PARTICULARITES

- *Metallisations "Or"*
- *Structure passivée* → *haute fiabilité*
- *Boitier céramique hermétique*
- *Resistances ballast d'émetteur* → *bonne tenue au ROS*
- *Structure auto-alignée* → *bonne reproductibilité des caractéristiques*

APPLICATIONS

Telécommunications dans la bande de frequences jusqu'à 108MHz

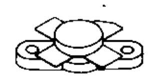
f = 108 MHz

P_{OUT} = 160 W

G_P = 9 dB

η_c = 75 %

V_{CC} = 28 V



Case / *Boitier* : CB-290 (.500 4L FL)

ABSOLUTE RATINGS (LIMITING VALUES) / ***VALEURS LIMITES ABSOLUES D'UTILISATION***	Symbols	Values	Units
Emitter-base (d.c.) voltage / *Tension continue emetteur-base* @ I_E = 20 mA	V_{EBO}	4	V
Collector-base (d.c.) voltage / *Tension continue collecteur-base* @ I_C = 100 mA	V_{CBO}	65	V
Collector-emitter (d.c.) voltage / *Tension continue collecteur-emetteur* @ I_C = 100 mA, R_{BE} = 10 Ω	V_{CES}	60	V
Collector (d.c.) current / *Courant continu de collecteur*	I_C	16	A
Storage and junction temperature range / *Températures extrêmes de stockage et de jonction*	T_{stg} / T_j	- 65 → + 200	°C / °C

Thermal resistance (junction-case) / *Résistance thermique (jonction-boitier)* @ P_D = 100W, T_c = 25°C	$R_{th(j-c)}$	0,75	°C/W

50, rue Jean-Pierre Timbaud - B.P. 5
F - 92403 Courbevoie Cedex FRANCE
Tél. : (1) 788-50-01 Telex : 610560 F

THOMSON-CSF COMPOSANTS

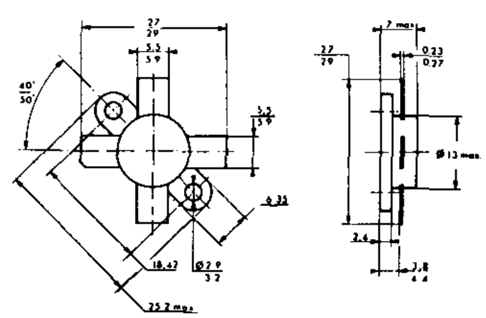
STATIC CHARACTERISTICS at t_{amb} = 25°C
CARACTERISTIQUES STATIQUES à t_{amb} = 25°C

Symbols	Values min.	Values typ.	Values max.	Units	Test conditions	
$V_{(BR)EBO}$	4			V	I_E = 20 mA	
$V_{(BR)CBO}$	65			V	I_C = 100 mA	
$V_{(BR)CES}$	60			V	I_C = 100 mA	
I_{CBO}				mA	V_{CB} = V	
H_{FE}	20		150		I_C = 1 A	V_{CE} = 5 V
C_{22b}			150	pF	V_{CB} = 28 V	f = 1 MHz

DYNAMIC CHARACTERISTICS at t_{amb} = 25°C
CARACTERISTIQUES DYNAMIQUES à t_{amb} = 25°C

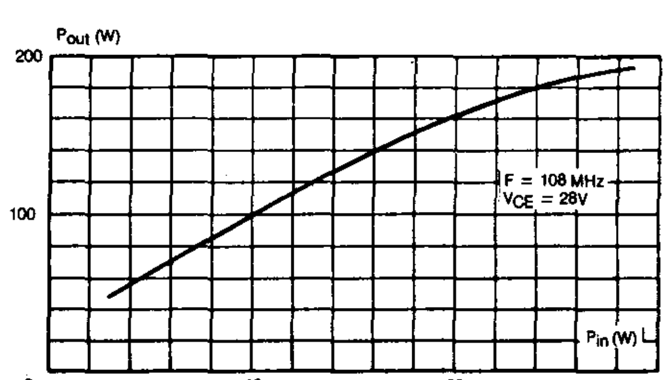
Symbols	Values min.	Values typ.	Values max.	Units	Test conditions
P_{OUT}		160		W	f = 108 MHz V_{CB} = 28 V P_{IN} = 20 W
G_P		9		dB	
η_c	70	75		%	

CASE DESCRIPTION
DESCRIPTION DU BOITIER



Dimensions in millimeters

CB-290
(.500 4LFL)



Output power versus input power (typical values)

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SECTION I

IPA THEORY OF OPERATION

1-1. INTRODUCTION.

1-2. The following text provides detailed theory of operation with supporting diagrams for the FM-10A IPA. For purposes of definition, the text is divided into functional circuits.

1-3. GENERAL DESCRIPTION.

1-4. The FM-10A IPA stage is a totally self-contained solid-state wideband FM amplifier providing a continuously variable output from 75 to 250 watts. The unit is mounted on slide rails for ease of maintenance.

1-5. The IPA consists of: 1) a power supply, 2) a voltage regulator circuit, and 3) an RF amplifier module (refer to Figure 1-1). Three front-panel indicators provide status information on module forward power, reflected power, and temperature conditions. The following text presents a detailed description of the IPA circuitry.

1-6. POWER SUPPLY.

1-7. The IPA power supply consists of a conventional full-wave bridge-rectified supply, a capacitor filter and bleeder, and a series regulator. The transformer primary has multiple taps which must be preset to minimize over-voltage and consequent over-dissipation of the regulator devices. This allows optimum efficiency to be obtained from the supply.

1-8. The power supply operates from an input of 194 to 275V ac at 2 Amperes and produces the following potentials:

+40 Vdc, filtered @ 18 Amperes

+40 Vdc, filtered)
+28 Vdc, regulated) @ 0.5 Amperes
+15 Vdc, regulated)

-1.3 Vdc @ 10 mA Stabilized

1-9. INTERCONNECT/FILTER CIRCUIT BOARD.

1-10. The interconnection filter circuit board provides internal connections between circuit boards, provides RFI filtering for the IPA status outputs, and provides interfacing for selected control inputs.

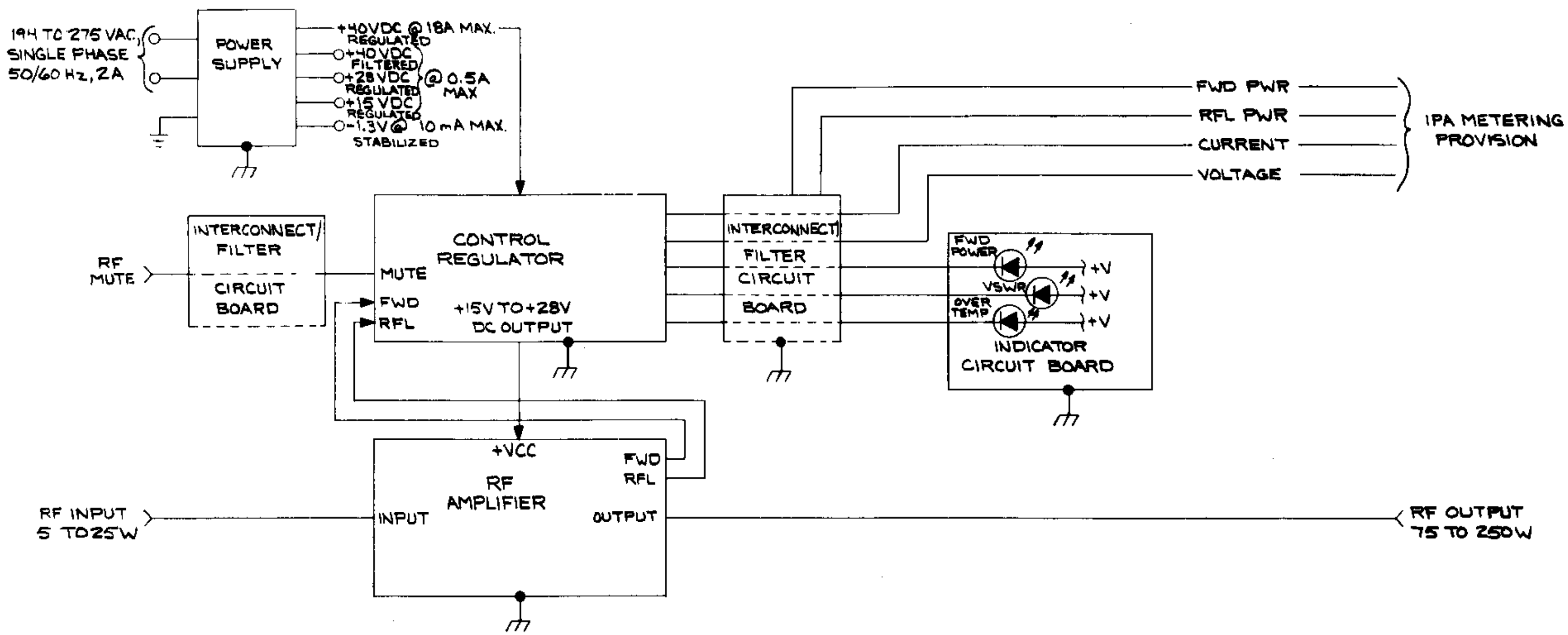

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FIGURE 1-1. IPA BLOCK DIAGRAM

1-11. CONTROL CIRCUIT BOARD.

1-12. The control circuit board regulates the operation of the RF amplifier within preset limits dependent upon several parameters such as reflected power and forward power or dc voltage, control regulator heat-sink temperature, dc current, and an external mute input. The control circuit board also contains amplifiers for the forward and the reflected directional couplers, the over-temperature circuit, and the IPA metering circuitry.

1-13. The regulator and control circuitry is contained on a printed circuit board with the output pass transistors mounted on an attached heatsink. Multiple paralleled devices are used to enhance reliability. The regulator is capable of supplying 28 volts at 18 Amperes of direct current. Voltage foldback will occur when excessive current is drawn or a high reflected power sample is evident. This protects the RF power transistors against output mismatch-induced damage. The drive signal or ac power must be momentarily removed to restore normal voltage from the regulator after foldback has occurred. A yellow front-panel mounted VSWR indicator indicates excessive reflected power into the output of the IPA with possible voltage foldback occurring when illuminated.

1-14. TEMPERATURE SENSOR. A temperature sensor is bonded to the regulator heatsink. This protects the output pass transistors from over-dissipation in the event of a fault by latching off the regulator driver circuit upon excessive temperature. A red front-panel mounted OVER TEMP indicator indicates this condition when illuminated. Removal of power is required to reset the operation of the regulator after an over-temperature condition has occurred.

1-15. RF AMPLIFIER.

1-16. The RF circuitry consists of two bipolar RF power transistors conservatively operated as a push-pull class C amplifier. Wide-band transmission-line matching sections transform impedances on the printed circuit board while providing for balanced push-pull operation of the transistors. Stripline networks along with chip capacitors match the base and collector elements of both transistors to the transmission line sections. A stripline directional coupler provides forward and reflected power samples. The IPA exhibits a minimum power gain of 10 dB.

1-17. Normal IPA amplifier operation is indicated by illumination of the green front-panel FWD POWER indicator (approximately 75 Watts of forward power). A high reflected power condition is indicated by illumination of the yellow front-panel VSWR indicator (approximately 8 Watts of reflected power) with possible foldback of the control regulator. Removal of the dc or RF input to the IPA stage is required to reset a foldback condition.

1-18. DETAILED DESCRIPTION.

1-19. POWER SUPPLY.

1-20. PRIMARY CIRCUIT. The IPA power supply operates from an input of 194 to 275 volts ac at a maximum of 2 Amperes (see Figure 1-2). AC power is input through RFI filter FL1 which provides 55 dB of attenuation to frequencies of 10 MHz and above. A special power transformer with a tapped dual primary allows operation from both 50 and 60 Hz as well as a wide range of ac input voltages without component changes. Compensation for different input voltages is accomplished by wiring changes to terminal strip TS1 and a power transformer secondary tap. If the supply is ever operated from a single-line input such as 120 volts ac, the fuse in the common side of the ac input must be jumpered out of the circuit for safety reasons. Refer to schematic diagram D959-0151 for input potentials and required wiring changes.

1-21. The cooling fan is connected across one primary of transformer T1 and runs continuously whenever ac power is applied. Fuses F1 and F2 provide overload protection for the primary circuit and metal-oxide varistor MOV1 provides suppression of voltage surges in excess of 250 volts.

1-22. SECONDARY CIRCUIT. The tapped secondary of T1 produces two ac voltages which are full-wave rectified into two dc supplies (39V and 35.5V average). C1 provides filtering, R1 acts as a bleeder, and fuse F3 provides overload protection for the secondary circuit. The +40 volt dc output is routed to the control regulator assembly where it is distributed and regulated into several different potentials.

1-23. Regulators. The 40 volt dc potential is fed directly to the pass transistor network mounted on the control regulator heat sink and to the regulators on the control regulator circuit board through fuse F1. The pass transistor network outputs a regulated potential to the RF amplifier to maintain a constant RF output in response to control parameters measured by the control regulator circuit board.

1-24. The 40 volt input to U1 is regulated into a +28 volt source. The +28 volt source is re-regulated by U2 into a +15 volt source. Regulators U1 and U2 are both three-terminal adjustable positive regulators containing internal thermal-overload protection and short-circuit current limiting features. Further protection for the regulators is provided by diodes D3 and D4, each which protects its respective regulator from a reverse polarity potential applied to the output and diodes D1 and D2, each which protects its respective regulator from a short circuit applied to the input.

1-25. Negative 1.3 Volt Supply. A negative 1.3 volt potential required for the metering circuit is developed from the output of U6B which is configured as an oscillator. The output of U6B is rectified by a voltage doubler consisting of C17, D14, and D15. The output of this supply is stabilized by diodes D16 and D17, each which provides a constant 0.65 volt drop to maintain the output at a constant -1.3 volts.

1-26. CONTROL REGULATOR.

1-27. The control regulator consists of a circuit board and a heatsink assembly which forms part of a closed loop with the RF amplifier. Jumper-plug programming allows feedback selection of either dc voltage and VSWR or forward RF power and VSWR for feedback (see Figure 1-3).

1-28. The regulator output voltage is established by a precision voltage drop, a series string of resistors, and the output voltage adjust control (R17). For a regulator output voltage of 28 volts, R17 must be adjusted to 14.8 volts on the wiper.

1-29. Plug P17 allows selection of a dc voltage as a regulator reference or an optional digital-to-analog converter reference. Resistor R20 provides an input to error amplifier U5A if P17 is inadvertently removed. The potential from P17 is applied to the non-inverting input to error amplifier U5A. Error amplifier U5A compares this input to the regulator output which is applied through a voltage divider to the inverting input. If the regulator output decreases, the output of U5A will increase. If the regulator output increases, the output of U5A will decrease. This control voltage is routed through steering diode D9 and level-shift diode D10 to a constant-current source.

1-30. Q1 and Q2 form a constant-current source which produces a stable current independent of the 40 volt regulator supply. The constant current generator assures that the current through R47 remains constant and independent of the foldback, mute, or over temperature circuits connected in parallel to the mute line. Diode D13 prevents an excessive voltage applied to the mute line from exceeding a limit which might damage Q1.

1-31. Regulator drive is applied to the base of Q1 which in turn drives regulator pass transistors Q2, Q3, and Q4. The dc supply for the regulator drive and the pass transistors is routed directly from the power supply high-current 40 volt source. A current balancing network for the pass transistors is provided by the output resistor network. The output of the output resistor network is applied to the RF amplifier load.

1-32. Either forward and reflected power feedback or dc voltage and reflected power feedback may be selected with jumper P18. When P18 is set to dc, a dc sample of the output voltage will be applied to the inverting input of U5A through R31 and R34. Resistor R24 provides an input to error amplifier U5A if P17 is inadvertently left out. A reflected power control signal will be added through diode D6 when the reflection is great enough to exceed the 0.7 volt drop across D6, approximately 15 volts at R22.

1-33. When P18 is set to FWD PWR, a dc potential representative of the IPA forward power level will be applied to the inverting input of U5A. Reflected power control will be added through Diode D5 when the reflection is great enough to exceed the 0.7 volt drop across D5.

1-34. CURRENT FOLDBACK. The output resistor network and the foldback resistor network work together to provide the current foldback action when the output current reaches 18 Amperes. If the regulator output is at the correct level, R51 will be essentially out of the circuit as there will be practically no current flow through the resistor. As the voltage across R59, R60, and R62 increases due to current increase, the voltage summed at the junction of R52 and R53 will increase with respect to the emitter of Q4. As Q4 is biased on, current will begin to flow through R51 which saturates Q4. This action grounds the mute line which removes the dc output. DC power must be interrupted to reset the foldback condition or removal of RF drive is required.

1-35. METERING. Current through the pass transistor output resistor network is used to generate the voltage used to meter output current. The transistor emitter connections are summed into the non-inverting input of U7A and the output side of the emitter resistor is connected to the inverting input of differential amplifier U7A. The current bal control (R72) adjusts the offset on U7A so that with zero current, the output is zero. The output of U7A is applied to U7B which acts as a meter driver. R76 allows adjustment of the stage calibration. The -1.3 volt supply is connected to the -Vcc connection of U7B so that a meter connected to U7B will properly register zero with no input. This below-ground reference is required with zero volt operation of the operational amplifier.

1-36. Forward Amplifier. The rectified output of the forward port of the directional coupler is applied to the forward meter amplifier of the control regulator circuit board. Non-inverting amplifier U3A has a high input impedance and high gain. The exact gain of the amplifier is adjusted by potentiometer R18. RF is filtered from the signal before entering the forward power meter amplifier by R7 and C5.

1-37. Reflected Amplifier. The reflected meter amplifier (U4A) works in a manner similar to the forward amplifier section except that the voltage gain of this amplifier is higher than the forward amplifier which compensates for the differences in the coupling factor of the directional coupler sampling lines. RF is filtered from the signal before entering the reflected amplifier by R8 and C6. U4A is calibrated by potentiometer R19.

1-38. The 15 volt full-scale output of U3A and U4A are routed through 3:1 dividers and voltage follower stages U3B and U4B to amplifiers U2A and U2B on the interconnect filter circuit board. The forward power signal is routed through comparator U1D and the reflected power output is routed through comparator U1E and applied to the front panel VSWR indicator. This indicator illuminates when over 8 Watts of power is reflected back into the IPA from the load. The FWD PWR indicator illuminates when the forward power is 75 Watts or greater.

1-39. REMOTE IPA MUTE. Provisions exist which allow the IPA stage RF output to externally muted using either a positive voltage or ground connection for control.

1-40. The mute input is applied to J9-5 if a positive voltage is used for muting or J9-6 if a ground is used for muting. When an input is applied, the optical coupler (U3 or U4) will pull the input to inverter U1F LOW which inhibits the drive applied to regulator driver Q1 and mutes the IPA RF output. The mute select jumper (P16) must be in the normal position to allow external muting. Diode D12 steers the input to prevent external devices from loading the mute line. The mute input is disconnected in the FM-10A, as RF muting is controlled in the FM exciter.

1-41. TEMPERATURE SENSOR. An electronic temperature sensing circuit consisting of U1 and U6A senses the control regulator heatsink temperature. If an over-temperature condition occurs, dc output will automatically be removed to prevent damage to the RF output transistors. Under normal conditions, the OVER TEMP indicator (DS3) on the front panel will remain off. As a visual indication that an over-temperature condition exists, the OVER TEMP indicator will illuminate.

1-42. Temperature sensor U1 is mounted on and is thermally coupled to the control regulator heatsink. U1 functions much as if it were a zener diode with a calibrated positive temperature coefficient. The sensor is calibrated by the TEMP CAL control (R30) so that the voltage between test point TP1 at the non-inverting input to U6A and ground is set to +2.98 volts when the heatsink temperature is +25 degrees Celsius and +2.73 volts at Ø degrees Celsius. U6A operates as a voltage comparator with +3.61 volts at test point TP2. This corresponds to an 88 degree Celsius comparison threshold.

1-43. At normal heatsink temperatures, the voltage output of U6A will hold Q3 biased off. As the voltage from U1 increases with heat rise at the rate of 10 millivolts per degree Celsius, U6A will trigger at the point preset by R30 and bias Q3 into conduction. Q3 will inhibit the drive applied to the regulator driver (Q1) and inhibit RF output.

1-44. In this manner, IPA is allowed to operate until a predetermined temperature is reached, then the RF output will be inhibited. An over-temperature condition is signaled by illumination of the OVER TEMP indicator (DS3) through inverter U1C. Zener diode D11 limits the input to U1C to a safe operating level if U6A should internally short. The IPA will return to operation as the temperature cools down.

1-45. RF AMPLIFIER.

1-46. The RF amplifier is a broadband stripline matched amplifier covering the FM broadcast band with a nominal output power of 150 Watts (see Figure 1-3). By adjusting the RF drive input, the RF power is variable over a range of 75 to 250 Watts.

1-47. The dc power input and the directional coupler outputs are connected to the circuit board through the chassis with feed-through capacitors to prevent RF interference. All wiring connects to the RF amplifier assembly through plugs to aid in maintenance.

1-48. POWER AMPLIFIER. Approximately 10 to 25 Watts of drive is input to the 50 Ohm primary of transformer T1 through a section of stripline. R10 acts as a swamping resistor to improve the input match and capacitor C1 tunes out the series reactance in the primary circuit of transformer T1. Capacitor C21 resonates the primary of T1 to improve the input match and the series combination of L4 and R1 effectively lowers the Q on the input circuit to allow a broadband match.

1-49. Transformer T1 provides a 4:1 step-down in impedance from 50 Ohms to two 12.5 Ohm sources, each source 180° out-of-phase. The output of T1 is capacitive coupled by a low-Q circuit to a matching network which further reduces the 12.5 Ohm impedance to approximately 1.5 Ohms to match the base impedance of Q1 and Q2. Base bias networks stabilize gain while C2 and C3 function as lumped matching elements in the impedance transformation. Capacitors C4/C5 and C6/C7 cancel out the inductive base reactance of Q1 and Q2.

1-50. Q1 and Q2 are NPN RF power transistors operated as a class C push-pull stage. The collector of each transistor feeds a stripline section which acts as a broadband impedance step-up transformer to convert the 0.5 Ohm collector impedance of each transistor to 6.25 Ohms. Capacitors C8 and C28 assist in the impedance transformation. Parallel connected inputs and series connected outputs of 25 Ohm coaxial cable raise the 6.25-6.25 Ohm push-pull outputs up to the 25-25 Ohm level. The series combination of R12 and C30 assure stable amplifier operation.

1-51. A coaxial cable balance-to-unbalance (balun) transformer converts the two 25 Ohm impedances to a single 50 Ohm unbalanced RF output. Capacitors C12 and C29 provide balanced transistor operation and paralleled capacitors C15/C31 block dc in the RF output line.

1-52. DIRECTIONAL COUPLER. The directional coupler provides two dc signals, each signal obtained by rectifying a portion of the RF output signal, coupled from a transmission line section etched into the circuit board. Due to the polarity of the two samples, one signal will be proportional to the forward traveling RF wave and the other signal will be proportional to the reflected traveling RF wave.

1-53. <u>Forward Directional Coupler Port</u>. The forward port of the directional coupler is broadbanded across the FM broadcast band. The voltage sample obtained is rectified by diode D2 and filtered by a PI-section filter. C19 improves the match due to the presence of D2. This output is routed to the control regulator for use in the control and metering circuits.

1-54. <u>Reflected Directional Coupler Port</u>. The reflected port of the directional coupler is broadbanded across the FM broadcast band. The voltage sample obtained is rectified by diode D1 and filtered by a PI-section filter. C17 improves the match due to the presence of D1. Inductor L3 in parallel with variable resistor R7 improves the linearity of the coupler across the band. R7 is adjusted to maximum directivity at the frequency of operation. This output is routed to the control regulator for use in the control and metering circuits.

SECTION II

IPA MAINTENANCE

2-1. INTRODUCTION.

2-2. This section provides maintenance information for the FM-10A IPA.

2-3. SAFETY CONSIDERATIONS.

2-4. The FM-10A transmitter contains high voltages and currents which, if regarded carelessly, could be fatal. The transmitter has many built-in safety features, however good judgement, care, and common sense are the best accident preventives. The maintenance information contained in this section should be performed only by trained and experienced maintenance personnel.

2-5. MAINTENANCE.

WARNING — NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

WARNING WARNING WARNING WARNING — DUE TO THE PROGRAMMING OF THE EQUIPMENT, THE APC UNIT WILL ENTER THE REMOTE ENABLED MODE WHENEVER AC POWER IS APPLIED. TO PREVENT INADVERTENT REMOTE START-UP DURING MAINTENANCE PERIODS, DISCONNECT POWER FROM THE TRANSMITTER AND INSTALL JUMPER P14 ON THE APC UNIT MAIN CIRCUIT BOARD IN POSITION 1-2.

2-6. The FM-10A maintenance philosophy consists of preventative maintenance such as cleaning applied to the equipment to prevent future failures and second level maintenance consisting of procedures required to restore the equipment to operation after a fault.

2-7. ADJUSTMENTS.

WARNING — NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

2-8. The following procedures present information required to adjust all controls in the IPA stage. These adjustments are factory preset and therefore will require readjustment only if components on the individual circuit boards have been replaced. Adjustments for the control regulator are presented first, followed by an adjustment procedure for the RF amplifier circuit board. The adjustments may be accessed by extending the IPA chassis forward on its slide rails out of the rack and removing the top cover.

2-9. OUTPUT VOLTAGE ADJUST (R17). To adjust the output voltage control (R17) on the control regulator circuit board, proceed as follows.

2-10. Required Equipment. The following equipment is required to adjust the output voltage adjust control (R17).

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

2-11. Procedure. To adjust the control, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-12. Disconnect primary power.

2-13. Connect the voltmeter between J4 pin 1 and chassis ground.

2-14. Operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to OFF. Operate the CONTROL, DRIVER, and BLOWER circuit breakers to ON.

2-15. Energize the transmitter primary ac power and depress the FILAMENT ON switch/indicator.

WARNING

WARNING

MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENTS WITHIN THE IPA WHEN POWER IS ENERGIZED.

WARNING USE AN INSULATED TOOL FOR ADJUSTMENT.

2-16. Using the insulated adjustment tool, adjust V OUT control R17 to obtain a voltmeter indication of +28.0 volts dc.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-17. Disconnect primary ac power.

2-18. Remove the test equipment and operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to ON.

2-19. FWD CALIBRATION. This adjustment is required if: 1) the transmitter diagnostic options indicate improperly, 2) the FWD POWER indicator threshold is incorrect by more than 10 Watts, or 3) if either the RF amplifier or control regulator assemblies are replaced. To adjust FWD calibration control R18 on the control regulator circuit board, proceed as follows.

2-20. Required Equipment. The following equipment is required to adjust the FWD calibration control.

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter (Fluke model 75 or equivalent).

D. 300 watt, non-inductive, 50 Ohm test load and connecting cable.

E. Calibrated in-line wattmeter and connecting cable (Bird 43 or equivalent with 250 watt element).

2-21. Procedure. To adjust the control, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-22. Disconnect primary power.

2-23. Remove the IPA top-panel and disconnect the cable from the RF amplifier output receptacle.

2-24. Connect the non-inductive test load to the RF amplifier output receptacle through the In-line Wattmeter. Adjust the wattmeter to measure forward power.

2-25. Connect the voltmeter between J9-17 on the IPA interconnect filter circuit board and chassis ground.

2-26. Operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to OFF. Operate the CONTROL, DRIVER, and BLOWER circuit breakers to ON.

2-27. Energize the transmitter primary ac power and depress the FILAMENT ON and HIGH VOLTAGE ON switch/indicators.

2-28. Depress the exciter FWD switch and record the RF output power ____________.

2-29. Using the exciter RF POWER OUTPUT ADJ control, obtain a wattmeter indication of 250 watts.

WARNING

WARNING

MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENTS WITHIN THE IPA WHEN POWER IS ENERGIZED.

WARNING — USE AN INSULATED TOOL FOR ADJUSTMENT.

2-30. Using the insulated adjustment tool, adjust FWD calibration control R18 on the control regulator circuit board to obtain a voltmeter indication of +5 volts dc.

2-31. Readjust the exciter RF output power to the level recorded in the preceding text.

WARNING — DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-32. Disconnect primary ac power.

2-33. Remove all test equipment and reconnect the cable to the RF amplifier output receptacle. Operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to ON.

2-34. RFL CALIBRATION. This adjustment is required if: 1) the VSWR indicator threshold is incorrect, 2) the VSWR foldback limits are incorrect, or 3) if either the RF amplifier or the control regulator assemblies are replaced. To adjust RFL calibration control R19 on the control regulator circuit board, proceed as follows.

2-35. Required Equipment. The following equipment is required to adjust the RFL calibration control.

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter (Fluke model 75 or equivalent).

D. Two 150 watt, non-inductive, 50 Ohm test loads and connecting cables.

E. BNC Tee (Pomona 3285).

F. Calibrated in-line wattmeter and connecting cable (Bird 43 or equivalent with 100 watt element).

2-36. Procedure. To adjust the control, proceed as follows:

WARNING — DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

NOTE — REFLECTED POWER NULL CONTROL R7 ON THE RF AMPLIFIER CIRCUIT BOARD MUST BE ADJUSTED BEFORE PERFORMING THE FOLLOWING PROCEDURE (SEE REFLECTED POWER NULL).

NOTE

2-37. Disconnect primary power.

2-38. Remove the IPA top-panel.

2-39. Disconnect the cable from the RF amplifier output receptacle and connect the BNC tee to the receptacle.

2-40. Attach one test load to the BNC tee. Attach the second test load to the BNC tee through the in-line wattmeter. Adjust the wattmeter to measure forward power.

2-41. Connect the voltmeter between J9-20 on the IPA interconnect filter circuit board and chassis ground.

2-42. Operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to OFF. Operate the CONTROL, DRIVER, and BLOWER circuit breakers to ON.

2-43. Energize the transmitter primary ac power and depress the FILAMENT ON and HIGH VOLTAGE ON switch/indicators.

2-44. Depress the exciter FWD switch and record the RF output power ____________.

2-45. Using the exciter RF POWER OUTPUT ADJ control, obtain a wattmeter indication of 75 watts.

WARNING — MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENTS WITHIN THE IPA WHEN POWER IS ENERGIZED.

WARNING

WARNING — USE AN INSULATED TOOL FOR ADJUSTMENT.

2-46. Using the insulated adjustment tool, adjust RFL calibration control R19 on the control regulator circuit board to obtain a voltmeter indication of +4.75 volts dc.

2-47. Readjust the exciter RF output power to the level recorded in the preceding text.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-48. Disconnect primary ac power.

2-49. Remove all test equipment and reconnect the cable to the RF amplifier output receptacle. Operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to ON.

2-50. TEMP CAL (R30). This adjustment is required only if the temperature sensor (U1) is replaced. To adjust the TEMP calibrate control (R30) on the control regulator circuit board, proceed as follows.

2-51. Required Equipment. The following equipment is required to adjust the TEMP calibrate control (R30).

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

D. Fluke 80T-150 temperature probe or equivalent Celcius indicating probe.

2-52. Procedure. To adjust the control, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-53. Disconnect primary power.

2-54. Attach the temperature probe to the control regulator heatsink assembly near U1.

2-55. Connect the probe to the voltmeter. Record the temperature indication, add +273, and divide by 100 $\left(\frac{°C + 273}{100} = \text{VOLTAGE}\right)$.

2-56. Connect the voltmeter between TP1 and chassis ground on the control regulator circuit board.

2-57. Operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to OFF. Operate the CONTROL, DRIVER, and BLOWER circuit breakers to ON.

2-58. Energize the transmitter primary ac power and depress the FILAMENT ON switch/indicator.

WARNING

WARNING

MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENTS WITHIN THE IPA WHEN POWER IS ENERGIZED.

WARNING — USE AN INSULATED TOOL FOR ADJUSTMENT.

2-59. Using the insulated adjustment tool, adjust TEMP calibrate control R30 to obtain an indication equal to the value calculated in the preceding text.

$$\text{EXAMPLE: } \frac{25°C + 273}{100} = \frac{298}{100} = 2.98 \text{ volts}$$

WARNING — DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-60. Disconnect primary ac power.

2-61. Remove the test equipment and operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to ON.

2-62. CURRENT BAL (R72). This adjustment is required only if the transmitter diagnostic options indicate a residual value when there is no RF output from the IPA. To adjust the CURRENT BAL control (R72) on the control regulator circuit board, proceed as follows.

2-63. Required Equipment. The following equipment is required to adjust the CURRENT BAL control (R72).

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

2-64. Procedure. To adjust the control, proceed as follows:

WARNING — DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-65. Disconnect primary ac power.

2-66. Connect the voltmeter between pin 7 of U7 and chassis ground.

2-67. Operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to OFF. Operate the CONTROL, DRIVER, and BLOWER circuit breakers to ON.

2-68. Energize the transmitter primary ac power and depress the FILAMENT ON switch/indicator.

WARNING

WARNING

MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH COMPONENTS WITHIN THE IPA WHEN POWER IS ENERGIZED.

WARNING

USE AN INSULATED TOOL FOR ADJUSTMENT.

2-69. Using the insulated adjustment tool, adjust CURRENT BAL control R72 to obtain a voltmeter indication of Ø.ØØ volts dc.

WARNING

DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-70. Disconnect primary ac power.

2-71. Remove the test equipment and operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to ON.

2-72. The CURRENT CAL control (R76) must now be adjusted. Refer to the following text.

2-73. CURRENT CAL (R76). This adjustment is required only if the transmitter diagnostic options indicate improper IPA current or if either the RF amplifier or control regulator circuit board is replaced. To adjust the CURRENT CAL control (R76) on the control regulator circuit board, proceed as follows.

NOTE

NOTE

CURRENT BAL CONTROL R72 ON THE CONTROL REGULATOR CIRCUIT BOARD MUST BE ADJUSTED BEFORE CURRENT CAL CONTROL R76 (REFER TO THE PRECEDING PROCEDURE).

2-74. Required Equipment. The following equipment is required to adjust the CURRENT CAL control (R76).

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

D. Resistor, 5 Ohm ±5%, 160 Watt, Wire Wound (BE P/N 130-0005).

2-75. Procedure. To adjust the control, proceed as follows:

WARNING — DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-76. Disconnect primary ac power.

2-77. Unplug P4-1 and P4-2 from J4-1 and J4-2.

2-78. Temporarily connect the 5 Ohm, 160 Watt resistor from J4-1 to J4-2.

2-79. Connect the voltmeter between pin 7 of U7 and chassis ground.

2-80. Operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to OFF. Operate the CONTROL, DRIVER, and BLOWER circuit breakers to ON.

2-81. Energize the transmitter primary ac power and depress the FILAMENT ON switch/indicator.

WARNING

WARNING — MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH COMPONENTS WITHIN THE IPA WHEN POWER IS ENERGIZED.

WARNING — USE AN INSULATED TOOL FOR ADJUSTMENT.

2-82. Using the insulated adjustment tool, adjust CURRENT CAL control R76 to obtain a voltmeter indication of +1.87 volts dc.

WARNING — DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-83. Disconnect primary ac power.

2-84. Remove the test equipment and reconnect P4-1 and P4-2 to J4-1 and J4-2, and operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to ON.

2-85. REFLECTED POWER NULL (R7). This control is factory calibrated and sealed during final test. Adjustment in the field is not normally required unless repairs have been made to the IPA directional coupler circuitry, the RF amplifier circuit board has been replaced, or the transmitter operating frequency has been changed. If it is certain adjustment is necessary, proceed as follows.

2-86. Required Equipment. The following equipment is required to adjust the reflected power null control (R7).

A. Flat blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

D. Test load and connecting cable (50 Ohm non-inductive, 300 Watt minimum).

E. Calibrated in-line wattmeter and connecting cable (Bird 43 with 250 Watt element or equivalent).

2-87. Procedure. To adjust the control, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-88. Disconnect primary ac power.

2-89. Disconnect the transmitter PA input cable and connect the test load to the IPA OUTPUT connector through the wattmeter. Adjust the wattmeter to indicate forward power.

2-90. Carefully prop the RF amplifier module in the cooling air path with R7 accessible through the hole provided in the module cover.

2-91. Connect the voltmeter between pin 7 of U4B on the control regulator circuit board and chassis ground.

2-92. Operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to OFF. Operate the CONTROL, DRIVER, and BLOWER circuit breakers to ON.

2-93. Energize the transmitter primary ac power and depress the FILAMENT ON and HIGH VOLTAGE ON switch/indicators.

2-94. Depress the exciter front-panel FWD switch and record the exciter RF power output ____________.

2-95. Adjust the exciter R.F. POWER OUTPUT ADJ. control as required to obtain approximately 200 to 250 Watts of forward power from the IPA.

WARNING WARNING WARNING WARNING	MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH COMPONENTS WITHIN THE IPA WHEN POWER IS ENERGIZED. EVEN THOUGH LOW VOLTAGES ARE USED THROUGHOUT THE IPA, IT IS POSSIBLE TO RECEIVE PAINFUL RF BURNS FROM THE RF AMPLIFIER.
WARNING	USE AN INSULATED TOOL FOR ADJUSTMENT.

2-96. Using the insulated adjustment tool, adjust reflected power null control R7 to obtain a minimum voltmeter indication.

2-97. Readjust the exciter RF power output to the level recorded in the preceding text.

WARNING	DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-98. Disconnect primary ac power.

2-99. Remove the test equipment, reconnect the transmitter load, and operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to ON.

NOTE NOTE	THE FOLLOWING PROCEDURE IS PART OF THE TRANSMITTER FREQUENCY CHANGE PROCEDURE. DO NOT PERFORM THE PROCEDURE UNLESS THE TRANSMITTER OPERATING FREQUENCY IS CHANGED.

2-100. RF AMPLIFIER TUNING (C28 AND C29). The following procedure is part of the TRANSMITTER FREQUENCY CHANGE PROCEDURE presented in PART I SECTION V. The following adjustment is required only if the transmitter operating frequency is changed. To tune the IPA RF amplifier, proceed as follows.

2-101. Required Equipment. The following equipment is required to tune the IPA RF amplifier.

A. Flat blade screwdriver, 1/4 inch tip.

B. No. 1 Phillips Screwdriver, 4 inch (10.16 cm) blade.

C. Insulated adjustment tool, flat tip (BE P/N 407-0083).

D. Test load and connecting cable (50 Ohm non-inductive 300 watt minimum).

E. Calibrated in-line wattmeter and connecting cable (Bird Model 43 with 250 element or equivalent).

2-102. Procedure. To tune the IPA RF amplifier, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-103. Disconnect all transmitter primary power before proceeding.

2-104. Disconnect the cable from the IPA OUTPUT receptacle and connect the test load to the OUTPUT receptacle through the in-line wattmeter. Adjust the wattmeter to indicate forward power.

2-105. Remove the cover from the IPA RF amplifier and carefully place the amplifier in the cooling air path with capacitors C28 and C29 accessible from the top of the chassis.

2-106. Operate the SCREEN, FILAMENT, and HIGH VOLTAGE circuit breakers to OFF. Operate the CONTROL, DRIVER, and BLOWER circuit breakers to ON.

2-107. Energize the transmitter primary ac power and depress the FILAMENT ON and HIGH VOLTAGE ON switch/indicators.

2-108. Tune the IPA RF amplifier as follows:

A. Observe the wattmeter indication.

WARNING IT IS POSSIBLE TO RECEIVE SERIOUS RF BURNS FROM THE AMPLIFIER. DO NOT ADJUST THE AMPLIFIER

WARNING MODULE WITH THE COVER REMOVED AND POWER ENERGIZED.

WARNING DEENERGIZE PRIMARY POWER BEFORE PROCEEDING.

B. Operate the DRIVER circuit breaker to OFF.

WARNING THE RF AMPLIFIER OPERATES AT HIGH TEMPERATURES. DO NOT TOUCH ANY COMPONENTS ON THE RF AMPLIFIER.

C. Adjust capacitor C28.

D. Operate the DRIVER circuit breaker to ON.

E. Repeat steps A through D for a maximum wattmeter indication using tuning control C28.

F. Repeat steps A through D for a maximum wattmeter indication using tuning control C29.

2-109. Once peak performance is obtained from the RF amplifier, ensure the IPA power output level is approximately equal to the value recorded in the factory final test data sheets. If required, adjust the exciter RF POWER OUTPUT ADJ control to obtain a satisfactory IPA output power indication.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-110. Disconnect all transmitter primary power before proceeding.

2-111. Disconnect all test equipment, replace the RF amplifier cover, reconnect the cable from the IPA OUTPUT to the PA INPUT, and operate the HIGH VOLTAGE, SCREEN, and FILAMENT circuit breakers to ON.

2-112. TROUBLESHOOTING.

WARNING
WARNING
WARNING

NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.

2-113. Most troubleshooting consists of visual checks. Because of the voltages and high currents in the transmitter, it is considered hazardous to work with power energized. Therefore, the various transmitter indicators (meters, LEDs, fuses, and circuit breakers) should be used to isolate the malfunction to one specific area.

2-114. If difficulties are encountered and the IPA is suspected as faulty, the first step in troubleshooting should determine whether the exciter, the RF amplifier, the control regulator, the power supply, or the load is at fault. A high VSWR condition or an over-heating condition will cause the control regulator to limit RF output to prevent damage to the IPA stage. The observable symptom would be loss of RF power. However, as the control regulator and the RF amplifier are both components of a closed loop, either circuit could cause this symptom. Complete loss of RF output would indicate power supply problems.

2-115. As a first check, the RF input level to the IPA stage should be checked and adjusted as required. Next the IPA load (INPUT TUNING control) should be adjusted to the correct point. If neither the input level or the output circuit is at fault, subsequent troubleshooting should determine which circuit is at fault.

WARNING BERYLLIUM OXIDE CERAMICS (BeO) - AVOID BREATHING DUST OR FUMES.

WARNING THE WHITE CASE MATERIAL OF THE IPA RF AMPLIFIER TRANSISTORS IS MADE OF BeO CERAMIC MATERIAL.
WARNING DO NOT PERFORM ANY OPERATION ON ANY BeO CERAMIC WHICH MIGHT PRODUCE DUST OR FUMES, SUCH AS GRINDING,
WARNING GRIT BLASTING, OR ACID CLEANING. BERYLLIUM OXIDE DUST OR FUMES ARE HIGHLY TOXIC AND BREATHING
WARNING THEM CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH. BeO CERAMICS MUST BE DISPOSED OF ONLY
WARNING IN A MANNER PRESCRIBED BY THE DEVICE MANUFACTURER. USE CARE IN REPLACING TRANSISTORS OF THIS
WARNING TYPE.

2-116. Characteristically, the type of RF transistors used in the IPA stage can fail partially, but still operate to some extent. If the RF power amplifier transistors are suspected as having inadequate gain, they must be replaced with new devices of the same identical type and manufacture as the original device. The IPA RF amplifier assembly diagrams in SECTION III contain information relative to replacement of the RF transistors. The transistors should be replaced in pairs to maintain matched gain for optimum push-pull operation. Due to the difficulty of replacing Q1 and Q2 in the field, it is recommended to return the RF amplifier module to Broadcast Electronics, Inc. for repair as chip capacitors C4 through C7 may have to be removed with Q1 and Q2.

2-117. Once the trouble is isolated and power is totally deenergized, it is suggested that the exact problem be located with resistance checks using the schematic diagrams and theory of operation presented throughout the text. Figures 2-1 and 2-2 should be referenced as troubleshooting aids.

2-118. If a circuit is diagnosed as faulty, the circuit fault may be isolated and repaired locally or the entire device may be returned to Broadcast Electronics, Inc. for exchange, alignment, or replacement. The modular approach used in the construction of the IPA allows spare control regulator or RF amplifier modules to be substituted in the system with minimal down time.

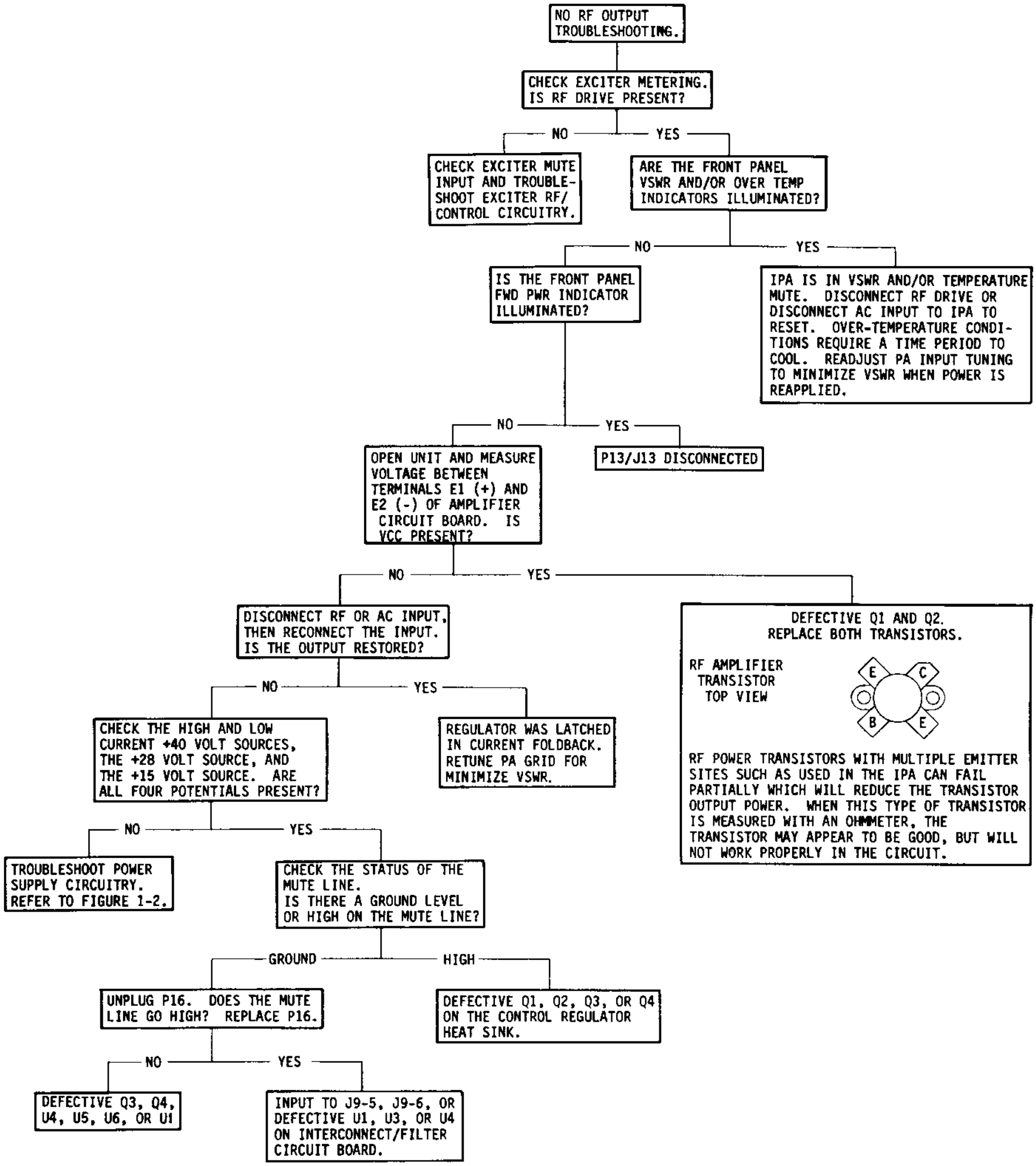

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FIGURE 2-1. NO RF OUTPUT TROUBLESHOOTING

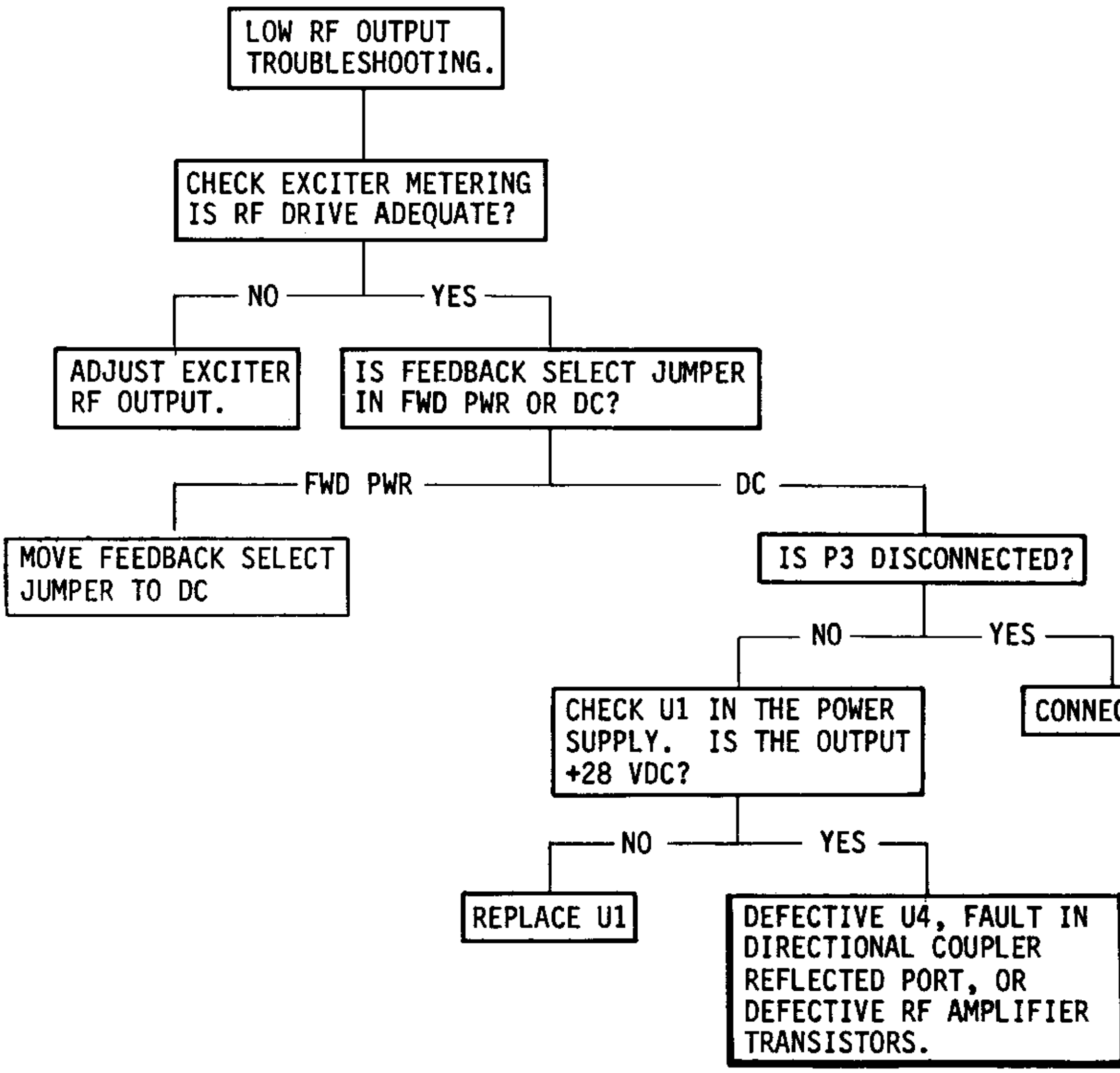

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FIGURE 2-2. LOW RF OUTPUT TROUBLESHOOTING

SECTION III
IPA DRAWINGS

3-1. INTRODUCTION.

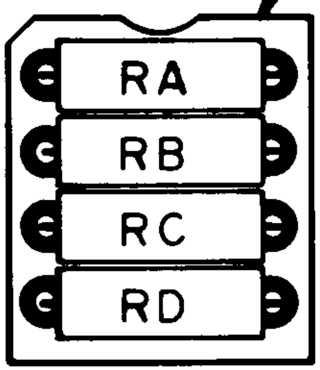
3-2. This section provides assembly drawings and schematic diagrams, as listed below for the FM-10A IPA.

REF	ZONE	REF	ZONE	REF	ZONE	REF	ZONE
C1	A2	D16	B1	R19	B2	R55	B3
C2	A3	D17	B1	R20	B1	R56	B3
C3	A2	D18	A2	R21	A1	R57	B3
C4	A2	D19	B3	R22	B1	R58	B3
C5	A2	F1	A3	R23	B1	R59	A3
C6	B2	J3	B2	R24	A1	R60	A3
C7	A2	J4	B3	R25	B1	R61	B1
C8	A1	J5	A1	R26	B1	R62	A3
C9	B1	J16	B1	R27	B2	R63	B1
C10	A2	J17	B1	R28	B2	R64	B1
C11	A1	J18	A1	R29	B2	R65	B3
C12	A1	P16	B1	R30	B2	R66	B3
C13	B2	P17	B1	R31	B1	R67	B3
C14	A2	P18	A1	R32	B3	R68	B1
C15	B3	Q1	B2	R33	B3	R69	B1
C16	A3	Q2	B2	R34	B1	R70	B1
C17	B2	Q3	A2	R35	B3	R71	B1
C18	B3	Q4	A2	R36	B2	R72	B1
C19	B1	R1	B2	R37	B3	R73	A1
C20	B3	R2	B2	R38	B2	R74	B1
C21	B2	R3	B2	R39	B2	R75	B1
D1	B2	R4	B2	R40	A1	R76	B1
D2	B2	R5	B2	R41	A1	R77	B1
D3	B2	R6	B2	R42	B3	TP1	A3
D4	B2	R7	B2	R43	A1	TP2	B2-B3
D5	B1	R8	B2	R44	B2	U1	A2
D6	B1	R9	B2	R45	B3	U2	A2-A3
D7	B2	R10	A1	R46	B2	U3	A1
D8	B2	R11	B2	R47	B2	U4	B2
D9	A1	R12	B1	R48	B3	U5	A1
D10	B2	R13	A1	R49	B3	U6	B3
D11	A1	R14	B2	R50	B3	U7	B1
D12	B2	R15	B1	R51	A2		
D13	B3	R16	B1	R52	A2		
D14	B2	R17	B1	R53	B3		
D15	B2	R18	B2	R54	B3		

597-0032-20

FIGURE 3-7. CONTROL REGULATOR CIRCUIT BOARD COMPONENT LOCATOR

B.E. PART NO. 418-0112



USED ON:
IPA 919-0042 PCB ON FM5A
AS R3.

B.E.I. PART NO. (VALUE IN OHMS)	RA	RB	RC	RD
100-1053 (10K)	X			
100-2243 (2.2K)		X		
100-1053 (10K)			X	
100-2743 (2.7K)				X

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL ±.01 3PL ±.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL

DRAWN BY MERKEL	DATE 2-22-83	CHECKED BY	DATE
PROJECT ENGR.	DATE	APPROVED BY	

TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.

TITLE ASSEMBLY RESISTOR NETWORK

A | DWG. NO. 959-1000-001 | REV. B

IPA - FM5A | SCALE 4/1 | SHEET 1 OF 1

SECTION IV

IPA PARTS LISTS

4-1. INTRODUCTION.

4-2. This section provides descriptions and part numbers of electrical components, assemblies, and selected mechanical parts required for maintenance of the Broadcast Electronics FM-10A IPA. Each table entry in this section is indexed by reference designators appearing on the applicable schematic diagram.

TABLE 4-1. IPA PARTS LIST INDEX

TABLE	DESCRIPTION	PART NO.	PAGE
4-2	OVERALL IPA	959-0131	4-2
4-3	IPA WIRING ASSEMBLY	949-0029	4-2
4-4	INTERCONNECT/FILTER CIRCUIT BOARD	919-0042	4-2
4-5	RF AMPLIFIER ASSEMBLY	959-0132	4-3
4-6	RF AMPLIFIER WIRING ASSEMBLY	949-0040	4-3
4-7	RF AMPLIFIER CIRCUIT BOARD	919-0065	4-4
4-8	CONTROL REGULATOR ASSEMBLY	959-0133	4-5
4-9	CONTROL REGULATOR WIRING ASSEMBLY	949-0039	4-5
4-10	CONTROL REGULATOR CIRCUIT BOARD	919-0045	4-5
4-11	TEMPERATURE SENSOR CIRCUIT BOARD	917-0030	4-7
4-12	RESISTOR ASSEMBLY NETWORK	959-1000-001	4-7

TABLE 4-2. OVERALL IPA - 959-0131

REF. DES.	DESCRIPTION	PART NO.	QTY.
B1	Fan, 115V, 50/60 Hz, 18W, 120 ft^3/min, 3100 r/min, 4.5 inch (11.43 cm)	380-4600	1
C1	Capacitor, Electrolytic, 22,000 uF, 50V	027-2200	1
D1	Bridge Rectifier, MDA3502, 200V, 35 Amperes, Silicon	230-3502	1
DS1	FWD PWR Indicator, LED, Green, 521-9175, 3V @ 40 mA Maximum	323-9224	1
DS2	VSWR Indicator, LED, Yellow, 521-9176, 3V @ 30 mA Maximum	323-9225	1
DS3	OVER TEMP Indicator, LED, Red, 521-9212, 2V @ 50 mA Maximum	323-9217	1
	220V AC Input Operation		
F1,F2,SPARE	Fuse, MDA, 250V, Slow-Blow, Ceramic Element, 4 Amperes	330-0401	3
	110V AC Input Operation		
F1,F2,SPARE	Fuse, 250V, 8 Amperes, Slow-Blow	330-0801	3
F3, SPARE	Fuse, 3AB, 250V, 20 Amperes	330-2000	2
FL1	Power Input Connector/RFI Filter, 3 Amperes, 250V ac, 50/60 Hz	339-0008	1
MOV1	Metal Oxide Varistor, V2506A15A, 250V ac RMS, 15 Joules	140-0008	1
R1	Resistor, 680 Ohm ±5%, 1/2W	110-6833	1
R2,R3	Resistor, 820 Ohm ±5%, 1/2W	110-8233	2
----	Transformer and Bracket Assembly	959-0195	1
T1	Transformer, Power, Single Phase, 50/60 Hz Primary: Dual 115 volt windings, one winding tapped at 90V Secondary: 33.1V @ 15 Amperes Continuous, Tapped at 30.2V	376-0040	1
TS1	Barrier Strip, 10 Terminal	412-0100	1
XF1,XF2	Fuse Holder, AGC	415-2012	2
XF3	Fuse Holder, Dual, 3AB	415-0003	1
----	Fuse Clips for Spare fuse, AGC	415-1001	2
----	Chassis Slides, Pair	469-0413-002	1
----	Receptacle, Top Cover Fastener	420-0022	8
----	Turn-Lock Fastener, Long	420-0019	6
----	Turn-Lock Fastener, Short	420-0027	2
----	Retainer, Turn-Lock Fastener	420-0021	8
----	Interconnect/Filter Circuit Board	919-0042	1
----	RF Amplifier Assembly	959-0132	1
----	Control Regulator Assembly	939-0133	1
----	IPA Wiring Assembly	949-0029	1
----	Blank Circuit Board, Front-Panel LED	519-0041	1

TABLE 4-3. IPA WIRING ASSEMBLY - 949-0029

REF. DES.	DESCRIPTION	PART NO.	QTY.
J10	Receptacle, BNC, Bulkhead UG-909	417-0106	1
J13	Receptacle, Type N	417-0076	1
P1,P2	Plug, BNC, Right Angle	417-0213	2
P1	Plug Assembly:		
	Contact, Male	418-0036	1
	Contact, Female	417-0100	1
	Housing	417-0099	1
P5,P6	Connector, Housing, 14-Pin In-line	417-1401	2
P7	Connector, Housing, 5-Pin In-line	417-0165	1
R1	Resistor, 1.8 k Ohm ±5%, 2W	130-1843	1
----	Pins, Receptacle (for Connectors P5, P6, and P7)	417-8766	30

TABLE 4-4. INTERCONNECT/FILTER CIRCUIT BOARD - 919-0042
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C8	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	8
C9,C10	Capacitor, Mylar Film, 0.1 uF ±5%, 100V	030-1053	2
C11 THRU C44	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	34

TABLE 4-4. INTERCONNECT/FILTER CIRCUIT BOARD - 919-0042
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C45	Capacitor, Electrolytic, 22 uF, 50V	024-2274	1
C46	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
D1,D2	Diode, 1N4148, Silicon, 100V, 10 mA	203-4148	2
J6	Receptacle, Header, 20-Pin In-line	417-0200	.70
J7	Receptacle, Header, 20-Pin In-line	417-0200	.30
J9	Receptacle, 25-Pin	417-2500	1
L1 THRU L9	Molded Choke, 4.7 uH ±10%, DC Resistance: 0.55 Ohms, 0.43 Amperes Maximum, Resonant at 130 MHz	360-0022	9
R1,R2	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	2
R3	Resistor Network Assembly	959-1000-002	1
R4,R5	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	2
R6	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R7	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R8	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R9	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R10 THRU R12	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	3
R13 THRU R18	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	6
R19,R20	Resistor, 1.2 k Ohm ±5%, 1/4W	100-1243	2
R21,R22	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	2
R23 THRU R26	Resistor, 1.2 k Ohm ±5%, 1/4W	100-1243	4
R27	Resistor, 100 Ohm ±5%, 2W	132-1033	1
R28 THRU R31	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	4
U1	Integrated Circuit, ULN2003A, 7-Channel Driver, CMOS/TTL Compatable, 16-Pin DIP	229-2003	1
U2	Integrated Circuit, 4N33, Optical Isolator NPN Photo Transistor/Infrared Emitting Diode Type, 1500 Isolation, 6-Pin DIP	229-0033	1
U3,U4	Integrated Circuit, LM358N, Dual Operational Amplifier, 8-Pin DIP	221-0358	2
XR3	Receptacle, 8-Pin DIP	417-0088	1
XU1	Receptacle, 16-Pin DIP	417-1604	1
XU2	Receptacle, 8-Pin DIP	417-0804	1
XU3,XU4	Receptacle, 6-Pin DIP	417-0600	2
----	Blank Circuit Board	519-0042	1

TABLE 4-5. RF AMPLIFIER ASSEMBLY - 959-0132

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C3	Capacitor, Ceramic, Feed-Thru, 1000 pF ±20%, 500V	008-1033	3
C4	Capacitor Assembly, Kapton, Feed-Thru, 100 pF		
	Kapton Dielectric	409-1817	2
	Nylon Insulator	423-6007	2
L1 THRU L6	Ferrite Bead	360-0003	6
----	RF Amplifier Wiring Assembly	949-0040	1
----	RF Amplifier Circuit Board	919-0065	1

TABLE 4-6. RF AMPLIFIER WIRING ASSEMBLY - 949-0040

REF. DES.	DESCRIPTION	PART NO.	QTY.
P3	Connector, Housing, 4-Pin In-line	417-0138	1
P4	Contact, Female	417-0100	2
	Housing	417-0099	1
----	Pins, Receptacle (for P3)	417-8766	3

TABLE 4-7. RF AMPLIFIER CIRCUIT BOARD - 919-0065

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Ceramic, Chip, 82 pF ±5%, 500V	009-8013	1
C2	Capacitor, Ceramic, Chip, 15 pF ±5%, 500V	009-1513	1
C3	Capacitor, Ceramic, Chip, 200 pF ±5%, 300V	009-2023	1
C4 THRU C7	Capacitor, Ceramic, Chip, 470 pF ±5%, 200V	009-4723	4
C8	Capacitor, Ceramic, Chip, 56 pF ±5%, 500V	009-5613	1
C9	Capacitor, Mylar, 0.22 uF ±10%, 100V	030-2253	1
C11	Capacitor, Mica, 100 pF ±10%, 350V	046-0001	1
C12	Capacitor, Ceramic, Chip, 15 pF ±5%, 500V	009-1513	1
C13	Capacitor, Mica, Feedthru, 1000 pF ±10%, 350V	046-1030	1
C14	Capacitor, Electrolytic, 22 uF, 50V	024-2274	1
C15	Capacitor, Ceramic, Chip, 470 pF ±5%, 200V	009-4723	1
C16	Capacitor, Mica, 1000 pF ±10%, 350V	046-0002	1
C17	Capacitor, Ceramic, 20 pF ±10%, 1kV	002-2013	1
C18	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C19	Capacitor, Ceramic, 20 pF ±10%, 1kV	002-2013	1
C20	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C22 THRU C25	Capacitor, Ceramic, Chip, 470 pF ±5%, 200V	009-4723	4
C26,C27	Capacitor, Ceramic, 0.001 uF ±10%, 1kV	002-1034	2
C28,C29	Capacitor, Mica, Adjustable Compression, 4 to 45 pF, 175V	090-0403	2
C30	Capacitor, Mylar, 0.22 uF ±10%, 100V	030-2253	1
C31	Capacitor, Ceramic, Chip, 470 pF ±5%, 200V	009-4723	1
D1,D2	Diode, HP5082-2800, High Voltage Schottky Barrier Type, 70V, 15 mA	201-2800	2
J11,J12	Receptacle, Right Angle BNC, UG535/U	417-0049	2
L2	RF Choke: 4 Turns of enameled 16 AWG wire on a 1/2 inch OD ferrite torroid form.	360-0025	1
L3,L4	RF Choke, 1.5 uH ±10%, 580 mA Maximum, DC Resistance = 0.30 Ohms	360-0032	2
L5	RF Choke, 0.15 uH, 1.47A dc Maximum, DC Resistance = 0.037 Ohms	360-0151	1
L6	RF Choke, Consists of BE P/N 360-0041 ferrite bead, OD = 0.13 inch, ID = 0.047 inch, L = 0.11 inch	360-0042	1
L7	RF Choke, 0.15 uH, 1.47A dc Maximum, DC Resistance = 0.037 Ohms	360-0151	1
L8	RF Choke, Consists of BE P/N 360-0041 ferrite bead, OD = 0.13 inch, ID = 0.047 inch, L = 0.11 inch	360-0042	1
Q1,Q2	Transistor, Pair, SD1460-4, NPN, Silicon, CB-290 Case	210-1460-001	1
R1	Resistor, 22 Ohm ±5%, 1/2W	110-2223	1
R2 THRU R4	Resistor, 10 Ohm ±5%, 1/2W	110-1023	3
R6	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R7	Potentiometer, 200 Ohm ±10%, 1/2W	177-2034	1
R8	Resistor, 200 Ohm ±1%, 1/4W	103-2003	1
R9	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R10	Resistor, 1 k Ohm ±5%, 2W	130-1043	1
R11	Resistor, 10 Ohm ±5%, 1/2W	110-1023	1
R12	Resistor, 22 Ohm ±5%, 2W	130-2223	1
R13	Resistor, 39 k Ohm ±5%, 1/4W	100-3953	1
R14	Resistor, 68 k Ohm ±5%, 1/4W	100-6853	1
T1	RF Input Transformer, Broadcast Electronics Manufacture Primary: 50 Ohms Impedance Secondary: 25 Ohm Impedance, CT	370-0008	1
W1,W2	Coaxial Cable Sections: 25 Ohm rigid coaxial cable matching section	610-0025	2
W3,W5	Coaxial Cable Sections: 50 Ohm rigid coaxial cable matching section	610-0026	2
Z1	Parasitic Suppressor: 20 Turns of enameled 16 AWG wire close wound on a 22 Ohm ±5% 2W carbon resistor (BE P/N 130-2223)	360-0024	1
----	Blank Circuit Board	519-0065	1

TABLE 4-8. CONTROL REGULATOR ASSEMBLY - 959-0133

REF. DES.	DESCRIPTION	PART NO.	QTY.
Q1	Transistor, MJ3000, Silicon, NPN Darlington, TO-3 Case	219-3000	1
Q2 THRU Q4	Transistor, 2N3055A, Silicon, NPN, TO-3 Case	218-3055	3
XQ1 THRU XQ4	Socket, TO-3 Transistor	417-0298	4
----	Insulator, Mica, TO-3 Transistor	418-0010	4
----	Control Regulator Wiring Assembly	949-0039	1
----	Control Regulator Circuit Board	919-0045	1
----	Temperature Sensor Circuit Board	917-0030	1

TABLE 4-9. CONTROL REGULATOR WIRING ASSEMBLY - 949-0039

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	Jack Assembly:		
	Contact, Male	418-0036	1
	Contact, Female	417-0100	1
	Housing	417-0098	1

TABLE 4-10. CONTROL REGULATOR CIRCUIT BOARD - 919-0045
(Sheet 1 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C4	Capacitor, Electrolytic, 22 uF, 50V	024-2274	4
C5,C6	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C7	Capacitor, Electrolytic, 22 uF, 50V	024-2274	1
C8,C9	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	2
C10,C11	Capacitor, Electrolytic, 22 uF, 50V	024-2274	2
C12	Capacitor, Electrolytic, 2.2 uF, 50V	020-2264	1
C13	Capacitor, Mylar Film, 0.01 uF, 100V	031-1043	1
C14	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C15	Capacitor, Polyester, 0.0022 uF ±10%, 100V	031-2033	1
C16 THRU C18	Capacitor, Electrolytic, 22 uF, 50V	024-2274	3
C19	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	1
C20	Capacitor, Electrolytic, 22 uF, 50V	024-2274	1
C21	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
D1 THRU D4	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	4
D5,D6	Diode, 1N4148, Silicon, 100V, 10 mA	203-4148	1
D7	Diode, Zener, 1N4733A, 5.1V, 1W	200-4733	1
D8,D9	Diode, 1N4148, Silicon, 100V, 10 mA	203-4148	2
D10	Diode, Zener, 1N4739A, 9.1V, 1W	200-0009	1
D11	Diode, Zener, 1N4744A, 15V, 1W	200-0015	1
D12	Diode, 1N4148, Silicon, 100V, 10 mA	203-4148	1
D13	Diode, Zener, 1N4752A, 33V, 1W	200-4752	1
D14 THRU D17	Diode, 1N4148, Silicon, 100V, 10 mA	203-4148	4
D18	Diode, Zener, 1N5363, 30V, 5W	200-5363	1
D19	Diode, 1N4005, Silicon, 600V @ 1 Ampere	203-4005	1
F1	Fuse, AGC, 250V, 1/2 Ampere	330-0050	1
J3	Receptacle, Header, 20-Pin In-line	417-0200	.20
J4	Receptacle, Header, 2-Pin	417-0097	1
J5	Receptacle, Header, 20-Pin In-line	417-0200	.70
J16 THRU J18	Receptacle, Header, 3-Pin	418-0003	3
P16 THRU P18	Plug, Shorting, 2-Pin	340-0004	3
Q1	Transistor, MPSA06, NPN, TO-92 Case	211-0006	1
Q2	Transistor, MPSA56, PNP, TO-92 Case	210-0056	1
Q3,Q4	Transistor, MPSA06, NPN, TO-92 Case	211-0006	2
R1	Resistor, 169 Ohms ±1%, 1/4W	103-1693	1
R2	Resistor, 7.32 k Ohm ±1%, 1/4W	103-7324	1
R3,R4	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	2
R5	Resistor, 115 Ohm ±1%, 1/4W	100-1131	1
R6	Resistor, 1.24 k Ohm ±1%, 1/4W	103-1244	1

TABLE 4-10. CONTROL REGULATOR CIRCUIT BOARD - 919-0045
(Sheet 2 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R7,R8	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R9	Resistor, 7.32 k Ohm ±1%, 1/4W	103-7324	1
R10	Resistor, 24 k Ohm ±5%, 1/4W	100-2453	1
R11	Resistor, 2.4 k Ohm ±5%, 1/4W	100-2443	1
R12	Resistor, 1.40 k Ohm ±1%, 1/4W	103-1404	1
R13	Resistor, 16 k Ohm ±5%, 1/4W	100-1653	1
R14	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R15	Resistor, 1.13 k Ohm ±1%, 1/4W	103-1134	1
R16	Resistor, 787 Ohm ±1%, 1/4W	103-7873	1
R17	Potentiometer, 10 k Ohm ±10%, 1/2W	178-1053	1
R18	Potentiometer, 100 k Ohm ±10%, 1/2W	178-1064	1
R19	Potentiometer, 50 k Ohm ±10%, 1/2W	178-5053	1
R20	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R21	Resistor, 1.1 k Ohm ±5%, 1/4W	100-1143	1
R22,R23	Resistor, 10 Ohm ±5%, 1/4W	100-1023	2
R24	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R25	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R26	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R27	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R28	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R29	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R30	Potentiometer, 10 k Ohm ±10%, 1/2W	178-1053	1
R31	Resistor, 2.49 k Ohm ±1%, 1/4W	103-2494	1
R32	Resistor, 11.0 k Ohm ±1%, 1/4W	103-1105	1
R33	Resistor, 3.57 k Ohm ±1%, 1/4W	103-3574	1
R34	Resistor, 2.21 k Ohm ±1%, 1/4W	103-2241	1
R35	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R36	Resistor, 12 k Ohm ±5%, 1/4W	100-1253	1
R37	Resistor, 5.6 Meg Ohm ±5%, 1/4W	100-5673	1
R38	Resistor, 390 Ohm ±5%, 1/4W	100-3933	1
R39	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R40 THRU R42	Resistor, 10 Ohm ±5%, 1/4W	100-1023	3
R43	Resistor, 1.2 k Ohm ±5%, 1/4W	100-1243	1
R44	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R45	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R46	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R47	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R48,R49	Resistor, 20 k Ohm ±5%, 1/4W	100-2053	2
R50	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R51	Resistor, 6.2 k Ohm ±5%, 1/4W	100-6243	1
R52	Resistor, 120 Ohm ±5%, 1/4W	100-1233	1
R53	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R54	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R55 THRU R57	Resistor, 22 Ohm ±5%, 1/4W	100-2223	3
R58	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R59,R60	Resistor, 0.1 Ohm ±1%, 5W, W/W	130-1000	2
R61	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R62	Resistor, 0.1 Ohm ±1%, 5W, W/W	130-1000	1
R63	Resistor, 4.99 k Ohm ±1%, 1/4W	100-5041	1
R64	Resistor, 1.00 k Ohm ±1%, 1/4W	103-1041	1
R65 THRU R67	Resistor, 22 Ohm ±5%, 1/4W	100-2223	3
R68 THRU R70	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	3
R71	Resistor, 9.76 k Ohm ±1%, 1/4W	103-9764	1
R72	Potentiometer, 500 Ohm ±10%, 1/2W	178-5000	1
R73	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R74	Resistor, 1.10 k Ohm ±1%, 1/4W	103-1104	1
R75	Resistor, 9.53 k Ohm ±1%, 1/4W	103-9534	1
R76	Potentiometer, 1 k Ohm ±10%, 1/2W	178-1043	1
R77	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
U1,U2	Integrated Circuit, LM317K, Three-Terminal Adjustable Positive Voltage Regulator, 1.2 to 37V, 1.5 Ampere Maximum, TO-3 Case	227-0318	1

TABLE 4-10. CONTROL REGULATOR CIRCUIT BOARD - 919-0045
(Sheet 3 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
U3 THRU U5	Integrated Circuit, LM358N, Dual Operational Amplifier, 8-Pin DIP	221-0358	3
U6	Integrated Circuit, LF353N, Dual JFET Input Operational Amplifier, 8-Pin DIP	221-0353	1
U7	Integrated Circuit, LM358N, Dual Operational Amplifier, 8-Pin DIP	221-0358	1
XF1	Fuse Clips, AGC	415-2068	2
XU3 THRU XU7	Socket, 8-Pin DIP	417-0804	5

TABLE 4-11. TEMPERATURE SENSOR CIRCUIT BOARD - 917-0030

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C3	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	3
U1	Integrated Circuit, LM335Z, Precision Temperature Sensor, TO-92 Case	229-0335	1
----	Blank Circuit Board	517-0030	1

TABLE 4-12. RESISTOR ASSEMBLY NETWORK - 959-1000-001

REF. DES.	DESCRIPTION	PART NO.	QTY.
R3A	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R3B	Resistor, 2.2 k Ohm, ±5%, 1/4W	100-2243	1
R3C	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R3D	Resistor, 2.7 k Ohm ±5%, 1/4W	100-2743	1
----	Plug, 8-Pin DIP	418-0112	1

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SECTION I

APC THEORY OF OPERATION

1-1. INTRODUCTION.

1-2. The following text provides theory of operation with supporting diagrams for the FM-10A automatic power control unit.

1-3. FUNCTIONAL DESCRIPTION.

1-4. Two levels of discussion are provided. A general discussion of the automatic power control unit operation at block diagram level is followed by a detailed discussion of circuit operation.

1-5. GENERAL DESCRIPTION.

1-6. The automatic power control unit (APC) monitors several transmitter parameters and allows both manual and automatic control of RF power output. Additional features include switched operation at a power level which has been predetermined (preset power), automatic power reduction in event of an output VSWR (VSWR foldback), and automatic reduction of power to minimum at plate-off so that when power is reapplied, full RF output will not suddenly be established, but will slowly increase from minimum (soft start). The unit also contains a front-panel test receptacle for AM noise measurements.

1-7. OPERATION. Manual screen control can be selected by switching the APC off. In the manual mode, the RAISE and LOWER switch/indicators directly control the dc servo motor which varies the screen voltage supply. The RAISE and LOWER switch/indicators are illuminated by the actual motor drive signal (see Figure 1-1).

1-8. In the automatic mode, the RAISE and LOWER switch/indicators control a reference voltage stored as an eight-bit word in a digital memory. A nine-volt battery maintains this memory after a power failure so that restoration to operation will proceed automatically after power is reapplied. Battery power consumption of 0.8 microamperes results in a battery life of approximately two years (the shelf life of an alkaline battery).

1-9. The dc servo motor control circuit in the APC uses duty-cycle modulation to vary the motor speed. When large excursions of screen voltage are required, a faster speed is utilized. Small adjustments of screen voltage utilize a shorter pulse duty cycle and consequently slower motor speed. The illumination intensity and flashing rate of the front panel RAISE and LOWER switch/indicators show in which mode the servo system is operating. The combination of a two-speed loop and analog "deadbands" in the circuitry eliminates over-shoot and hunting of the servo loop.

1-10. Five circuit-board mounted LED indicators provide information concerning operation of the APC for maintenance personnel. Each indicator will illuminate to signify its respective function or parameter is active or out-of-tolerance.

1-11. The APC houses the circuitry which rectifies and calibrates the PA directional coupler forward and reflected power signals. These signals serve as APC control inputs and are applied to the OUTPUT POWER meter for measurement. These parameters, PA screen current, and IPA forward power allow automatic control of the PA screen voltage as part of a closed loop employing a dc servo-motor driven variable autotransformer. If excessive PA reflected power, excessive screen current, or low IPA power is measured, the "raise power" function will be inhibited to prevent an overload condition. The absence of plate voltage will inhibit the raise function and signal the circuit to adjust the screen voltage to minimum. Excessive transmitter RF output or a high PA reflection will first inhibit the raise function. If the condition exceeds built-in limits, the circuit will initiate a sequence which lowers power proportionately in response to the condition.

1-12. VSWR Foldback. In the automatic mode, PA power will be automatically reduced if PA reflected power becomes excessive enough to overload the transmitter. As the condition which caused the high VSWR returns to normal, RF power will be proportionally raised until full output is restored. A similar circuit for PA forward power will reduce power if the output is excessive. The balance of these two circuits stabilizes the transmitter output at a specific level.

1-13. Soft Start. In the automatic mode, a circuit monitors plate voltage and reduces the screen voltage to zero upon the absence of plate voltage. When the plate supply is energized, as during power-on, the circuit will gradually increase the screen voltage until the "stored" power level is achieved. This circuit prevents inadvertent cycling of the VSWR overload at turn-on if the load is not optimal, such as during an ice storm.

1-14. Preset Power. The preset power function provides a simple means to switch the transmitter output power to a predetermined level other than the rated output power. This feature can be conveniently activated with a generator for emergency operation at a lower power level.

1-15. Emergency Back-Up Operation. Emergency adjustment of the screen adjust motor is possible even with the APC main circuit board removed for maintenance. The jumper-plug arrangement and the emergency back-up raise/lower switch on the rear panel circuit board will allow application of a 25 volt potential obtained directly from the power transformer on the chassis for clockwise or counterclockwise rotation of the motor as desired.

1-16. Power Supply. The APC power supply consists of two +15 volt regulated sources, a +12 volt regulated source, and a +9.9 volt source established by a zener diode. Each +15 volt supply is fused with a one-ampere fuse. The entire supply is overload protected by two half-ampere fuses in the primary circuit. The tranformer secondary of 25 Vac is half-wave rectified to provide a potential to operate the motor if the emergency back-up operation provision is used.

1-17. DETAILED DESCRIPTION.

1-18. The APC unit circuitry is implemented on three circuit boards with certain additional components (such as the power transformer) mounted to the chassis.

A. The front panel circuit board contains the switch/indicators and some resistors which calibrate the OUTPUT POWER METER circuitry.

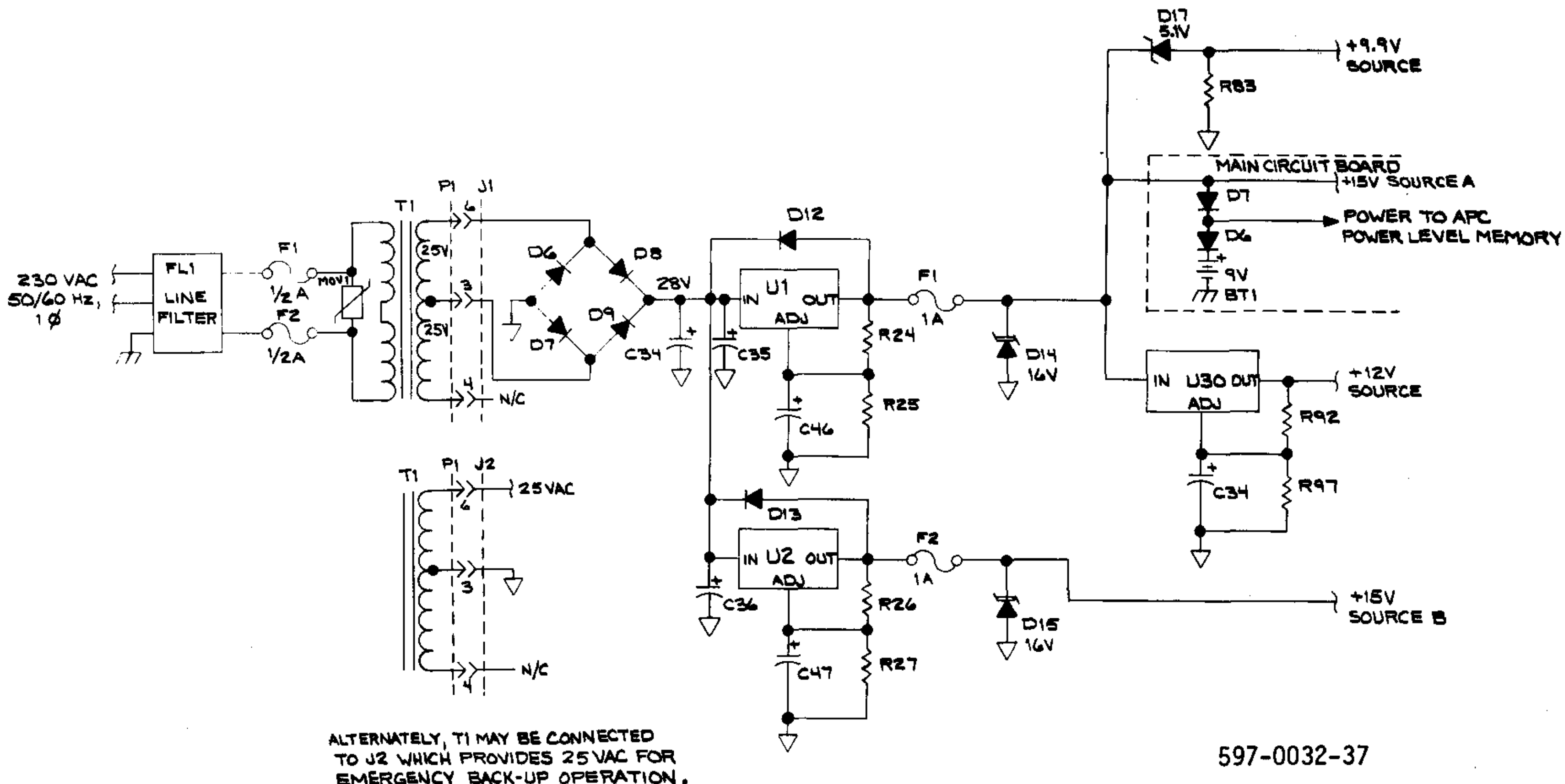
B. The rear panel circuit board primarily contains interface circuitry. It 1) contains the forward and reflected power rectifier circuitry, 2) the PI section low-pass filters which provide RFI filtering for all ac, dc and control inputs, 3) the power supplies which operate the unit, and 4) the emergency bypass circuitry which allows manual screen voltage raise and lower control even with the main circuit board removed.

C. The main circuit board contains all the circuitry required to implement the APC analog and digital control functions.

1-19. POWER SUPPLY. The APC power supply operates from an input of 230 volts ac at a maximum of 1/2 ampere (see Figure 1-2). AC power is input through RFI filter FL1 which provides 55 dB of attenuation to frequencies of 10 MHz and above. A conservatively rated power transformer allows operation from both 50 and 60 Hz. Fuses F1 and F2 provide overload protection for the primary circuit and metal-oxide varistor MOV1 provides suppression of transient voltage surges.

1-20. The secondary of transformer T1 is full-wave bridge rectified by diodes D6, D7, D8, and D9 into a +28 volt source and filtered by C34. This potential is regulated into four seperate sources. The transformer plug (P1) may be moved to J2 to provide 25 Vac for emergency back-up screen voltage raise/lower switch operation.

1-21. Positive Fifteen Volt Source A. The input potential is regulated into a 15 volt supply by U1. Capacitor C35 prevents regulator oscillation and C46 improves the response of the regulator. The output voltage is established by the value of resistors R24 and R25. The output of this supply operates all APC logic.



ALTERNATELY, T1 MAY BE CONNECTED TO J2 WHICH PROVIDES 25VAC FOR EMERGENCY BACK-UP OPERATION.

597-0032-37

FIGURE 1-2. APC POWER SUPPLY

1-22. Integrated circuit U1 is a three-terminal adjustable positive regulator containing internal thermal overload protection and short-circuit current limiting features. Overload protection for U1 is provided by fuse F1. Diode D14 protects the regulator from a reverse polarity potential applied to the output and provides transient suppression for all voltages exceeding 16 volts. Diode D12 protects the regulator from possible damage resulting from an input short.

1-23. A second supply connected to the output of U1 consists of regulator U30 which re-regulates the input into a 12 volt source which is applied to the PRESET CAL control and the 8-bit digital-to-analog converter on the main circuit board.

1-24. A third supply connected to the output of U1 consists of zener diode D17 and resistor R83. These components establish a 9.9 volt source which is used as a reference for precision current sources for the close-tolerance comparators on the main circuit board.

1-25. In case of power failures, the supply to the APC power level memory circuit will be maintained by a battery. Diode D7 prevents battery discharge through the APC circuitry during periods of battery operation and diode D6 isolates the 9 volt battery from the 15 volt A supply. Battery drain is approximately 0.8 microamperes which allows approximately two years of use (depending on the battery type). The battery is not maintained on charge and must be replaced when discharged.

1-26. Positive Fifteen Volt Source B. The power supply input potential is regulated into a 15 volt supply by U2. Capacitor C46 prevents regulator oscillation and C47 improves the response of the regulator. The output voltage is established by the value of resistors R26 and R27. The output of this supply operates all APC indicators and provides power for the APC output stages.

1-27. Integrated circuit U2 is a three-terminal adjustable positive regulator containing internal thermal overload protection and short-circuit current limiting features. Overload protection for U2 is provided by fuse F2. Diode D15 protects the regulator from a reverse polarity potential applied to the output and provides transient suppression for all voltages exceeding 16 volts. Diode D13 protects the regulator from possible damage resulting from input shorts.

1-28. APC LOGIC CIRCUITRY.

1-29. MANUAL OPERATION. Manual operation refers to operation of the transmitter with the automatic power control circuitry switched off (APC ON switch/indicator not illuminated). In this mode, RF power output is not automatically controlled, but responds only to manual raise and lower commands (see Figure 1-3).

1-30. When the APC unit is switched off, the $\overline{Q}$ output of U3A will go HIGH which selects the A inputs to the manual/automatic selector (U14). A HIGH through U7A and U9A will clear any preset power command. Fast speed correction is selected by a HIGH applied to analog switch U13B through U10A and U9C.

1-31. The local and remote raise power commands are applied to NOR gate U34C and the local and remote lower power commands are applied to NOR gate U34D. Each NOR gate will output the logical sum of its inputs. If the Q output of U3B is HIGH (remote disable), the remote inputs will be inhibited as one input of NOR gates U34A and U34B will be held HIGH.

1-32. The logic configuration used prevents simultaneous raise and lower commands. In event both commands are simultaneously initiated, U7B will give the lower power command priority over the raise power command by holding a HIGH on one input of NOR gate U7C.

1-33. The raise or lower power command will be routed through U14 which functions as if it were a four-pole double-throw relay. In this situation, the "A" inputs will be routed to the outputs as follows:

Z0 will output a LOW if power raise was selected.

Z1 will output a LOW if power lower was selected.

Z2 will output a HIGH to U10D to prevent the power reference counter from counting down.

Z3 will output a HIGH to U8B to prevent the power reference counter from counting up.

1-34. A 9.77 Hertz square-wave is applied as a clock to flip-flop U4B through analog switch U13B and is also applied as a set input to U4B. The resultant output forms the signal that actually drives the motor. This drive signal is gated by NAND gate U12B with inverted 9.77 Hertz square-wave from U12A. The resultant logical sum of the inputs to U12B is a rather short-duration pulse which is applied to the motor through U10B or U10C as a power raise or a power lower signal. This gating of the motor drive pulse through U4B, U12A and U12B forms a precise short-duration motor drive signal and minimizes motor coasting without the requirement for dynamic braking.

1-35. The power raise or power lower drive is then applied through an inverter to a Darlington output stage. When there is no command to raise or lower power, both outputs will be HIGH. When there is a command to raise or lower power, the one output will go LOW. Current through DS5 (the LOWER indicator) or DS4 (the RAISE indicator) will actually display the motor drive signal.

1-36. The primary of the screen power transformer is controlled by variable autotransformer which is driven by a dc gearmotor. As the motor is a series-wound dc type, the speed at which the motor turns may be controlled by the duty cycle of the applied drive signal. Limit switches on the motor prevent possible damage to the autotransformer by disconnecting the drive signal at the end of travel for each direction.

1-37. AUTOMATIC OPERATION. When power is first applied to the APC, a high-going pulse will be generated by U11 which resets the command logic as follows. The duration of the pulse is determined by the value of C1, R1, and R2.

A. The APC on flip-flop (U3A) will be set to Q = HIGH to signify that the APC is on.

B. The remote disable flip-flop (U3B) will be set to the condition selected by the remote control power-up mode select jumper plug (P14). The following discussion will assume this jumper is set to disable remote control in which case Q = HIGH to signify remote control disable. The REMOTE DISABLE indicator will illuminate to signify that the remote control inputs are inhibited and additional outputs inform the optional microprocessor video display system of the remote control states, as well as a separate logic output on the remote control terminal block.

C. The preset power flip-flop (U4A) will be set to Q = LOW via NOR gate U7A and inverter U9A. This action will clear any preset power command at power-on.

D. Inverter U20A will hold a LOW on U22A to disable the power level memory inputs until power is fully energized.

1-38. The HIGH from U3A will inform the optional microprocessor video diagnostic system that the APC is enabled via U15A, illuminate the front-panel APC ON switch/indicator via U15B, and select the "B" inputs to the manual/automatic selector (U14).

1-39. The LOW from U4A will hold one input to NOR gate U8A LOW to disable the preset inputs. The HIGH from U8A will inform the optional microprocessor video diagnostic system that the preset power option is disabled via U15F, enable NOR gate U10D via U12C which allows raise memory reference, and enables the automatic level analog switch (U13C). The HIGH from U8A through inverter U9B will hold the front-panel PRESET switch/indicator off via U15E, disable the preset power analog switch (U13D), and enable NOR gate U8B which allows lower memory reference.

1-40. Normally, the power level memory battery (BT1) will always be installed and transistor Q5 will constantly be energized. When power is applied to the transmitter, current will be applied to the up/down counter (U23/U24). As the reset line to the up/down counter is normally held LOW by Q5, the count representative of the transmitter RF power output will be retained.

1-41. If, however, the power level memory battery is discharged, current will be applied to the up/down counter with Q5 off which resets the up/down counter to minimum count, representative of minimum transmitter RF power output. After a short delay determined by the value of C24, R58, and R59, Q5 will energize and the reset line will go LOW to terminate the reset.

1-42. During periods of battery operation, diode D7 prevents battery discharge through the power supply and diodes D8 through D15 prevent battery discharge through the digital to analog converter. The battery is not maintained on charge and is isolated from the power supply by diode D6. When the battery is discharged, it must be replaced with a new battery. The only circuitry backed-up by the battery is the up/down counter, composed of U22, U23 and U24.

1-43. Assuming that the up/down counter count has been retained, the up/down counter will begin to output eight-bit digital words as soon as the 2.44 Hertz clock is applied via U22A. The eight-bit digital output of the up/down counter is converted to a dc level by the digital-to-analog converter (U26/U26). This level is buffered by U28A and routed through analog switch U13C (which was selected when the APC ON switch was depressed) to voltage follower U32B.

1-44. If the count in the up/down counter was not preserved and was reset at power-on, the count must be manually re-established with the front-panel RAISE and LOWER switches.

1-45. The raise and lower command input circuit operates in a manner identical to that described by the manual operation discussion, however these inputs do not move the screen control motor directly as in manual operation, but change the count stored in the up/down counter (U23, U24) which establishes the RF output with a dc reference level.

1-46. The raise or lower power commands from the front-panel switches will be routed through U14 which functions as if it were a four-pole, double-throw relay. In this situation, the "B" inputs will be routed to the outputs as follows:

Z2 will output a LOW if power reference raise was manually selected.

Z3 will output a LOW if power reference lower was manually selected.

1-47. Any LOW from the Z2 output of U14 for power reference lower is applied through U10D to inverter U9D and bistable flip-flop U17B/U17C. The second input of U10D will inhibit power reference raise if preset power has been selected or an abnormal operating condition is signaled by U33B.

1-48. Any LOW from output Z3 of U14 for power reference raise is applied through U8B to inverter U9E and bistable flip-flop U17B/U17C. The second input to U8B will inhibit power reference lower if preset power has been selected.

1-49. When the output of inverter U9D or U9E goes LOW, the resultant output of flip-flop U17B/U17C will enable the up/down counter to count up or count down. A HIGH from the flip-flop will enable the counter to count up. A LOW from the flip-flop will enable the counter to count down. U22A will toggle the clock of the up/down counter (U23/U24) when either a lower or raise reference command is passed by U17A. The carry output of U24, the up/down counter, when LOW, stops the up/down counter from "rolling over" at maximum (1111 1111) or minimum (0000 0000) count.

1-50. PA Forward Power Control Circuit. Voltage follower U32B sinks current from constant current source U29A and Q6 to establish three precise voltages across the series string of resistors R96B and R96C. These voltages create dead-bands or windows which determine how the PA forward power control circuit will react when PA forward power increases beyond the level established by the input to U32B.

1-51. A sample of forward power from the PA forward meter amplifier (U18A) is applied to the inverting inputs of U31A, U31B, and U32A. If the PA forward power decreases to the extent that the level applied to the inverting input of U32A falls below the fixed reference on the non-inverting input of U32A, the output of voltage comparator U32A will change states and output a HIGH. This HIGH will force a LOW from U10A which is inverted by U9C to energize analog switch U13B for fast-speed correction. This allows fast correction when the forward power differs greatly from the fixed set-point.

1-52. The motor speed is determined by the duty cycle of the drive signal. In automatic operation, slow-speed and fast-speed correction is used. The lower frequency signal from U13B will drive the motor faster as the duty cycle of the drive signal is greater. The higher frequency signal from U13A will drive the motor slower as the duty cycle is less and the motor "on time" is less.

1-53. As PA forward power increases to the proper level (approximately 90% power), the level applied to the inverting input of U32A will rise above the fixed reference on the non-inverting input of U32A. The output of voltage comparator U32A will change states and output a LOW. This LOW will force a HIGH from U10A which energizes analog switch U13A for slow-speed correction. The HIGH from U10A will also illuminate the SLOW SPEED LED on the circuit board via U11A. U9C inverts this HIGH to deenergize analog switch U13B, the fast-speed gate.

1-54. If PA forward power then increases, the level on the inverting input of U31B will rise above the fixed reference on the non-inverting input of U31B. The output of voltage comparator U31B will change states and output a HIGH to U17D which inhibits further raise functions. This is the lower edge of the set-point "window" or deadband. It is usually 1% to 2% below the desired power setting.

1-55. If the PA power should continue to increase to the point which is 1% to 2% above the desired setting, the level on the inverting input of U31A will rise above the fixed level on the non-inverting input of U31A and U31A will output a HIGH. This HIGH is inverted by U20D and applied as a LOW to U33A which lowers power.

1-56. As the PA power is lowered to the normal level, the potential on the inverting inputs of U31A and U31B will fall. First, U31A will return to a LOW output which removes the power lower command from U33A. The power will remain at this point within the set-point deadband. If the power should drop further, then U31B will return to a HIGH output which will output the raise command from U17D. The circuit will now function normally to control power, maintaining operation within the deadband.

1-57. The raise or lower power command will be routed through U14 which functions as if it were a four-pole, double-throw relay. In this situation, the "B" inputs will be routed to the outputs as follows:

Z0 will output a LOW via NAND gate U17D if automatic power raise is required. A LOW input to U17D from U33B will inhibit the raise function.

Z1 will output a LOW via NOR gate U33A if automatic power lower is required.

1-58. The remainder of the control circuitry functions in a manner identical to that described by the manual operation discussion.

1-59. <u>PA Reflected Power Control Circuit</u>. A sample of reflected power from the PA reflected meter amplifier (U18B) is applied to the inverting inputs of U27A and U27B.

1-60. Constant current source U29A/Q7 establishes two precise voltages across the series string of resistors R82C and R82B. The voltage across R82C creates a dead-band or "window", which determines how the PA reflected power control circuit will react when PA reflected power increases beyond the level established by the reference on the non-inverting inputs of voltage comparators U27A and U27B.

1-61. The circuit will remain idle when the PA reflected power is below acceptable limits. If the PA reflected power increases and the level applied to the inverting input of U27B rises above the fixed reference on the non-inverting input of U27B (determined by the voltage across R82B), the output of voltage comparator U27B will change states and output a LOW. This LOW is applied as a HIGH to the raise inhibit gate (U33B) through inverter U20C to prevent PA power from increasing and illuminates the HIGH VSWR LED on the circuit board via inverter U11B. This prevents the forward power control circuit from raising power if a high VSWR exists, preventing transmitter overload.

1-62. If the PA reflected power continues to rise, the level on the inverting input of U27A will rise above the fixed reference on the non-inverting input and U27A will change states to output a LOW. This LOW is applied as a HIGH to the power lower gate (U33A) through inverter U20B to lower power. Thus, R82C establishes a "deadband", within which no raising or lowering power will occur.

1-63. When PA reflected power falls to a safe level and the level on the inverting input of U27A falls below the fixed reference on the non-inverting input, U27A will output a HIGH. This HIGH is applied as a LOW to U33A via U20B to halt the power reduction. However the raise command will still be inhibited by U27B at the lower edge of the deadband.

1-64. If the PA reflected power continues to fall, the level on the inverting input of U27B will fall below the fixed reference on the non-inverting input and U27B will change states to output a HIGH. The resultant LOW from inverter U20C will enable U33B and allow power raise functions as required by the forward power control circuit. The automatic power control unit will then function normally again with full raise/lower control of the screen voltage.

1-65. Forward and Reflected Power Circuits. The directional coupler located at the output end of the low-pass filter provides RF voltages proportional to the PA forward and reflected power. The reflected power sample is rectified by a voltage doubler (D2 and D4 on the rear panel circuit board), calibrated by R44, and amplified by U18B. The forward power sample is rectified by a voltage doubler (D1 and D3), calibrated by R42, and amplified by U18B. A low-pass filter after the rectifiers attenuates carrier envelope modulation caused by power supply ripple and synchronous audio rate amplitude modulation.

1-66. The reflected power signal is applied to the PA reflected power control circuit and the metering circuit. The forward power signal is applied to the PA forward power control circuit and the metering circuit. The metering information is applied to the OUTPUT POWER METER switch and displayed by the OUTPUT POWER meter. R17 provides a means to calibrate the OUTPUT POWER meter without affecting the setup of the automatic system set by R42 and R44. This allows adjustment for routine calibration.

1-67. Plate Voltage Monitor Circuit. The soft start circuit monitors actual PA plate voltage. This circuit reduces the PA screen potential to minimum whenever plate voltage is off. Whenever the plate voltage is above the trip point, the circuit will gradually increase the PA screen voltage until the rated transmitter RF output is established unless limited by low IPA drive, excessive screen current, or a high VSWR condition, as gated by U33B.

1-68. A plate voltage sample derived from the plate meter multiplier circuit board is applied to the inverting input of voltage comparator U19A. When the plate voltage sample decreases below the fixed level (approximately 2.5 volts) on the non-inverting input of U19A established by R38 and R39 (such as when the high voltage power supply is off), U19A will output a HIGH. This HIGH will be applied to both the raise inhibit gate (U33B) and the lower power gate (U33A). U33B will inhibit the raise function and U33A will lower power to minimum. The HIGH from U19A will also illuminate the PLATE OFF LED on the circuit board via U11C. The power control element will stop lowering at minimum setting, but the lower command will remain present at the output of U33A through U12D.

1-69. When the HIGH VOLTAGE ON switch/indicator is depressed, the plate voltage sample from the plate meter multiplier circuit board will rise above the fixed reference on the non-inverting input and U19A will output a LOW. This LOW will remove the raise inhibit from U12C and U17D via U33B to raise power and will remove the power lower signal from U33A to allow the APC circuitry to re-establish transmitter RF power output as previously discussed.

1-70. Screen Current Monitor Circuit. A sample of PA screen current obtained from the negative side of the screen supply is applied to the inverting input of voltage comparator U19B. It is biased positive by voltage divider consisting of R35 on main circuit board and R4 on the rear panel circuit board. When the screen current increases, the voltage on the inverting input of U19B will fall below the fixed level on the non-inverting input and U19B will output a HIGH. This HIGH is applied to the raise inhibit gate (U33B) to prevent PA power from increasing and illuminates the HIGH SCREEN CURRENT LED on the circuit board via inverter U11D.

1-71. When the PA screen current returns to normal and the screen current sample falls below the fixed level on the non-inverting input, U19B will output a LOW. This LOW will remove the raise inhibit from U12C and U17D via U33B and allow PA power to increase.

1-72. <u>IPA Forward Power Monitor Circuit</u>. A dc voltage representative of the reflected power from the IPA directional coupler is applied to the inverting input of voltage comparator U28B. When the IPA power decreases below the fixed level on the non-inverting input established by current source Q8 and resistor R89B, U28B will output a HIGH. This HIGH is applied to the raise inhibit gate (U33B) to prevent PA power from increasing. The HIGH from U28B will also illuminate the LOW DRIVE POWER LED on the circuit board via inverter U11E.

1-73. When the IPA power returns to normal, the IPA forward power sample will rise above the fixed reference on the non-inverting input and U28B will output a LOW. This LOW will remove the raise inhibit from U12C and U17D via U33B and allow PA power to increase.

1-74. PRESET POWER. As an additional function, a preset power level may be selected by the front-panel PRESET switch/indicator or activated with a continuous positive voltage connection to one of the APC preset power inputs (the APC must be enabled). This feature is normally used to automatically switch the transmitter to a predetermined power output level such as half-power for periods of auxiliary generator operation. The APC functions as before, only the internal POWER reference is manually adjusted by potentiometer R87.

<u>NOTE</u> PRESET POWER IS ONLY USED FOR EMERGENCY OPERATION AT LESS THAN LICENSED POWER OPERATION.

<u>NOTE</u> NO PROVISION TO REMOTELY ADJUST POWER IS PROVIDED IN THIS MODE.

1-75. The local, remote, and microprocessor video display system generated preset power inputs are applied to NOR gate U8A which outputs the logical sum of its inputs. If preset power is selected by any source, the output of U8A will be a HIGH. This HIGH accomplishes the following:

A. Deenergizes the automatic power control analog switch (U13C).

B. Disables NOR gate U10C via U12C to inhibit raise memory. Thus no change in the original APC power setting can occur if the RAISE switch is inadvertently depressed.

C. Informs the optional microprocessor video diagnostic system via U15F that the preset power function is energized.

D. Disables NOR gate U8B via U9B to inhibit lower memory. No change in the original APC power setting can occur if the LOWER switch is inadvertently depressed.

E. Energizes the preset analog switch (U13D).

F. Illuminates the front-panel PRESET switch/indicator via U15E as a local indication that the preset power function is energized.

1-76. The transmitter power output will now be determined by the setting of the preset cal potentiometer (R87) on the main circuit board. If power is removed from the APC unit, even momentarily, the preset power command will be automatically reset. The preset power mode will remain energized, however, if the remote input is connected to a voltage source.

1-77. EMERGENCY OPERATION. During normal operation, P1 on the rear panel circuit board will be connected to J1. If the APC circuitry fails and the main circuit board must be removed for repairs, the transmitter RF output power may be manually controlled by disconnecting P1 from J1 and connecting P1 to J2. The transmitter RF output power may now be controlled with the emergency backup raise/lower switch (S1) on the rear panel circuit board. The potential required for screen control motor operation is obtained from half of the APC power transformer secondary. Half-wave rectification for the dc motor is provided by D5. This mode bypasses all electronics except the fuses, transformer, and auxiliary diodes for a redundant control system.

SECTION II
APC MAINTENANCE

2-1. INTRODUCTION.

2-2. This section provides maintenance information for the FM-10A Automatic Power Control Unit (APC).

2-3. SAFETY CONSIDERATIONS.

2-4. The FM-10A transmitter contains high voltages and currents which, if regarded carelessly, could be fatal. The transmitter has many built-in safety features, however good judgement, care, and common sense are the best accident preventives. The maintenance information contained in this section should be performed only by trained and experienced maintenance personnel.

2-5. MAINTENANCE

WARNING — NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

WARNING WARNING WARNING WARNING — DUE TO THE PROGRAMMING OF THE EQUIPMENT, THE APC UNIT WILL ENTER THE REMOTE ENABLED MODE WHENEVER AC POWER IS APPLIED. TO PREVENT INADVERTENT REMOTE START-UP DURING MAINTENANCE PERIODS, DISCONNECT POWER FROM THE TRANSMITTER AND INSTALL JUMPER P14 ON THE APC UNIT MAIN CIRCUIT BOARD IN POSITION 1-2.

2-6. The FM-10A maintenance philosophy consists of preventative maintenance such as cleaning applied to the equipment to forestall future failures and second level maintenance consisting of procedures required to restore the equipment to operation after a fault.

2-7. ADJUSTMENTS.

WARNING — NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

2-8. The following procedures present information required to adjust all controls in the APC. These adjustments are factory preset and therefore will require readjustment only if components in the specific circuit has been replaced. Adjustments for the main circuit board are presented first, followed by an adjustment procedure for the front-panel circuit board. The adjustments may be accessed by extending the APC chassis forward on its slide rails out of the rack and removing the top cover.

2-9. FWD CAL (R42). This adjustment will be required only if repairs have been made to the directional coupler forward port, the low-pass filter has been replaced, or if potentiometer R42 has been replaced. If the transmitter OUTPUT POWER meter forward power display only requires calibration, refer to paragraph 2-44. To adjust the FWD CAL control (R42) on the main circuit board, proceed as follows.

2-10. Required Equipment. The following equipment is required to adjust the FWD CAL control (R42).

A. Flat-blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

D. Test load and connecting line (50 Ohm non-inductive, 1 5/8 inch line input, 10 kW minimum).

E. Calibrated in-line wattmeter with 1 5/8 inch sampling section and cables (Bird 4720 Thruline with 10 kW element or equivalent).

2-11. Procedure. To adjust the control, proceed as follows:

WARNING ASSURE ALL PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-12. Disconnect primary power.

2-13. Connect the voltmeter between U18A, pin 1 and chassis ground.

2-14. Connect the test load and wattmeter to the transmitter output.

WARNING

WARNING

MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENTS WITHIN THE APC WHEN POWER IS ENERGIZED.

WARNING USE AN INSULATED TOOL FOR ADJUSTMENT.

2-15. Apply power and operate the transmitter in the local manual mode (REMOTE DISABLE illuminated, APC ON out) at the licensed RF power output as indicated by the in-line wattmeter.

2-16. Using the insulated adjustment tool, adjust R42 on the main circuit board for a voltmeter indication of +5.00V dc.

NOTE

NOTE

THE TRANSMITTER OUTPUT POWER METER SHOULD INDICATE 100%. IF NOT, ADJUST R17 PER PARAGRAPH 2-44 BEFORE PROCEEDING.

WARNING

ASSURE ALL PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-17. Disconnect primary power.

2-18. Remove the test equipment and reconnect the transmitter output to the antenna load.

2-19. RFL CAL (R44). This adjustment will be required only if repairs have been made to the directional coupler reflected port, the low-pass filter has been replaced, or potentiometer R44 has been replaced. To adjust the RFL CAL control (R44) on the main circuit board, proceed as follows.

2-20. Required Equipment. The following equipment is required to adjust the RFL CAL control (R44).

A. Flat-blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

C. RF millivoltmeter, 50 Ohm input (Boonton Model 92B with Model 91-12F RF probe and Model 91-8B 50 Ohm adapter or Fluke Model 85 RF probe or equivalent).

D. BNC plug-to-plug adapter, UG-491B/U (BE P/N 417-0116).

E. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

2-21. Procedure. To adjust the control, proceed as follows:

NOTE

NOTE

NOTE

CORRECT ADJUSTMENT OF R44 REQUIRES THAT THE OUTPUT OF U18B BE ADJUSTED TO +5.00V DC WITH A 10% TRANSMITTER RF OUTPUT REFLECTION. IN THE FOLLOWING PROCEDURE, THE FORWARD PORT OF THE DIRECTIONAL COUPLER IS CLOSELY CALIBRATED AND USED AS A SIGNAL SOURCE TO CALIBRATE R44.

2-22. Operate the transmitter at 100% power output and verify the VSWR CAL control is set at 100%.

2-23. Determine the RMS voltage (E) required to calibrate R44 as follows:

Transmitter 100% RF output power=________Watts.
10% of transmitter rated RF output power=________Watts =P.

<u>FORMULA</u> $$E = \frac{\sqrt{P \times 50\ \text{Ohms}}}{100}$$

<u>EXAMPLE</u> Transmitter rated RF output power = 9000 Watts.
10% of transmitter RF output power = 900 Watts (P).

$$E = \frac{\sqrt{900 \times 50}}{100} \qquad E = \frac{\sqrt{45000}}{100}$$

$$E = \frac{212.13}{100} \qquad E = 2.12\ \text{VRMS}$$

<u>WARNING</u> ASSURE ALL PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-24. Disconnect primary power.

2-25. Connect the voltmeter between U18B, pin 7 and chassis ground.

2-26. Disconnect cables 625 and 626 from the APC and route cable 625 out the top of the transmitter.

2-27. Assemble the RF millivoltmeter probe, 50 Ohm termination, and the BNC plug-to-plug adapter.

2-28. Connect the RF millivoltmeter to cable 625.

2-29. Apply power and operate the transmitter in the local manual mode (REMOTE DISABLE illuminated, APC ON out).

2-30. Manually adjust the transmitter RF output power to obtain a millivoltmeter indication of the voltage (E) calculated in paragraph 2-23.

<u>WARNING</u> ASSURE ALL PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-31. Disconnect primary power.

2-32. Disconnect the millivoltmeter from cable 625. Route the cable back inside the transmitter and connect cable 625 to the APC RFL PWR RF SAMPLE input (J10).

<u>WARNING</u> MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENTS WITHIN THE APC WHEN POWER IS ENERGIZED.

<u>WARNING</u>

<u>WARNING</u> USE AN INSULATED TOOL FOR ADJUSTMENT.

2-33. Apply power and operate the transmitter in the local manual mode (REMOTE DISABLE illuminated, APC ON out).

2-34. Using the insulated adjustment tool, adjust R44 on the main circuit board for a voltmeter indication of +5.00V dc.

<u>WARNING</u> ASSURE ALL PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-35. Disconnect primary power.

2-36. Remove the test equipment, reconnect cable 625 from the APC FWD PWR RF SAMPLE input (J9) to the FWD directional coupler port, and reconnect cable 626 from the APC RFL PWR RF SAMPLE input (J10) to the RFL directional coupler port.

2-37. PRESET CAL (R87). This adjustment determines the power level which the transmitter will output when the preset power circuit is energized. The RAISE or LOWER controls have no effect on this adjustment. To adjust the PRESET CAL control (R87) on the main circuit board, proceed as follows.

2-38. <u>Required Equipment</u>. The following equipment is required to adjust the PRESET CAL control (R87).

A. Flat-blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

2-39. <u>Procedure</u>. To adjust the control, proceed as follows:

WARNING — MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENTS WITHIN THE APC WHEN POWER IS ENERGIZED.

WARNING

WARNING — USE AN INSULATED TOOL FOR ADJUSTMENT.

2-40. Apply power and operate the transmitter in the local automatic mode (REMOTE DISABLE and APC ON illuminated).

2-41. Operate the OUTPUT POWER METER switch to FWD.

2-42. Depress the PRESET POWER switch/indicator.

2-43. Using the insulated adjustment tool, adjust R87 until the desired percentage of RF power output is indicated by the OUTPUT POWER meter.

2-44. OUTPUT METER CALIBRATE (R17). This adjustment will be required only if the OUTPUT POWER meter or potentiometer R17 is replaced. To adjust the output meter calibrate control (R17) on the front panel circuit board, proceed as follows.

2-45. The FWD CAL control (R42) must be checked and adjusted if required before R17 is adjusted (refer to paragraph 2-9).

2-46. Required Equipment. The following equipment is required to adjust the output meter calibrate control (R17).

A. Flat-blade screwdriver, 1/4 inch tip.

B. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

C. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

D. Test load and connecting line (50 Ohm non-inductive, 1 5/8 inch line input, 10 kW minimum).

E. Calibrated in-line wattmeter with 1 5/8 inch sampling section and cables (Bird 4720 Thruline with 10 kW element or equivalent).

2-47. Procedure. To adjust the control, proceed as follows:

WARNING ASSURE ALL PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-48. Disconnect primary power.

2-49. Connect the voltmeter between U18A, pin 1 and chassis ground.

2-50. Connect the test load and wattmeter to the transmitter output.

WARNING MAINTENANCE WITH POWER ENERGIZED IS ALWAYS CONSIDERED HAZARDOUS AND THEREFORE CAUTION SHOULD BE OBSERVED. DO NOT TOUCH ANY COMPONENTS WITHIN THE APC WHEN POWER IS ENERGIZED.

WARNING

WARNING USE AN INSULATED TOOL FOR ADJUSTMENT.

2-51. Apply power and operate the transmitter in the local manual mode (REMOTE DISABLE illuminate, APC ON out) at the desired 100% RF power output as indicated by the in-line wattmeter.

2-52. Using the insulated adjustment tool, adjust the FWD CAL control (R42) on the main circuit board for a voltmeter indication of +5.00V dc.

2-53. Operate the OUTPUT POWER METER switch to FWD.

2-54. Using the insulated adjustment tool, adjust R17 to obtain a 100% OUTPUT POWER meter indication. The VSWR CAL control must also be adjusted to 100% at this time.

WARNING ASSURE ALL PRIMARY POWER IS DISCONNECTED BEFORE PROCEEDING.

2-55. Disconnect primary power.

2-56. Remove the test equipment and reconnect the transmitter output to the antenna load.

2-57. TROUBLESHOOTING.

<u>WARNING</u> NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE
<u>WARNING</u> THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS
<u>WARNING</u> ARE DISCHARGED BEFORE ATTEMPTING MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.

2-58. Most troubleshooting consists of visual checks. Because of the high voltages and currents in the transmitter, it is considered hazardous to work with power energized. Therefore, the various transmitter indicators (meters, LEDs, fuses, and circuit breakers) should be used to isolate the malfunction to one specific area.

2-59. Once the trouble is isolated and power is totally deenergized, it is suggested that the exact problem be located with resistance checks using the schematic diagrams and theory of operation presented throughout the text.

2-60. If a circuit is diagnosed as faulty, the circuit fault may be isolated and repaired locally or the entire device may be returned to Broadcast Electronics, Inc. for exchange, alignment, or replacement.

SECTION III

APC DRAWINGS

3-1. <u>INTRODUCTION</u>.

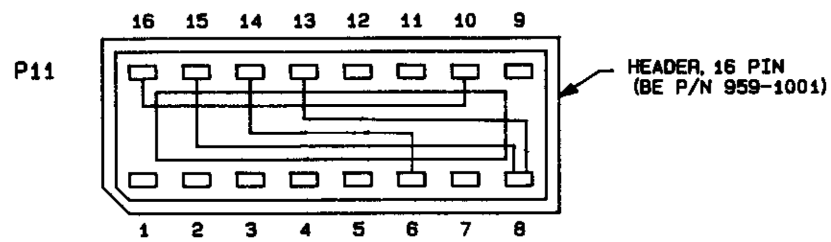
3-2. This section provides assembly drawings and schematic diagrams, as listed below for the FM-10A Automatic Power Control Unit.

REF	ZONE	REF	ZONE	REF	ZONE	REF	ZONE	REF	ZONE	REF	ZONE
BT1	C4	C39	B1	R2	B3	R41	A1	R80	A1	U5	C3
C1	B3	D1	A4	R3	B3	R42	A1-A2	R81	A1	U6	C3
C2	B2	D2	C3	R4	B3	R43	A2	R82	B1	U7	A2-A3
C3	A4	D3	C3	R5	B3	R44	A1	R83	B1	U8	C3
C4	C3	D4	A3	R6	B3	R45	A1	R84	A4	U9	C2-C3
C5	C3	D5	A3	R7	B3	R46	B2	R85	--	U10	A3
C6	C3	D6	C4	R8	B3	R47	C1	R86	C1	U11	B2
C7	C2	D7	C4	R9	A4	R48	--	R87	A1	U12	A2-A3
C8	A3	D8	C4	R10	A4	R49	A1	R88	--	U13	C2
C9	C2	D9	C4	R11	B3	R50	--	R89	B1	U14	A3
C10	A3	D10	C4	R12	B3	R51	B2	R90	B1	U15	C3
C11	A3	D11	C4	R13	B3	R52	C1	R91	C1	U16	C1
C12	C1	D12	B4	R14	B3	R53	A1	R92	C2	U17	C2-C3
C13	A2	D13	B4	R15	B3	R54	A1	R93	C2	U18	A1
C14	A1	D14	B4	R16	B3	R55	B1	R94	B1	U19	B2
C15	A3	D15	B4	R17	C3	R56	B2	R95	--	U20	A2
C16	--	D16	C3	R18	C3	R57	A4	R96	A1	U21	C1
C17	A1	D17	B1	R19	C3	R58	C4	R97	--	U22	A4
C18	C1	DS1	B2	R20	C3	R59	C4	R98	--	U23	C4
C19	B2	DS2	B2	R21	C3	R60	C4	R99	B1	U24	B4
C20	A1	DS3	B2	R22	B2	R61	B4	R100	B1	U25	B4
C21	B1	DS4	B2	R23	C3	R62	C3	R101	B1	U26	A4
C22	C1	DS5	B2	R24	C3	R63	C4	R102	C1	U27	A1-A2
C23	A4	J4	A3-B3	R25	C4	R64	B4	R103	B1	U28	A4
C24	C4	J5	A2	R26	C3	R65	C4	R104	B2	U29	B1
C25	B4	J11	C1-C2	R27	A3	R66	B4	R105	B2	U30	C1-C2
C26	B4	J12	C3	R28	A2	R67	C4	R106	B2	U31	B1
C27	A4	J13	C3	R29	A3	R68	B4	R107	B2	U32	C1
C28	A1	J14	B2-B3	R30	C3	R69	C4	R108	B1	U33	B2
C29	B1	J15	C2	R31	A2	R70	--	R109	C4	U34	B3
C30	A4	Q1	A3	R32	B3	R71	--	R110	B3		
C31	C2	Q2	A3	R33	C4	R72	B4	R111	C1		
C32	B1	Q3	A3	R34	C3	R73	B4	R112	C1		
C33	C1	Q4	A3	R35	A3	R74	B4	R113	B1		
C34	C1-C2	Q5	C3	R36	--	R75	B4	TP1	C1		
C35	C1	Q6	B1	R37	--	R76	A4	U1	B2-B3		
C36	C2	Q7	B1	R38	B2	R77	A4	U2	A4		
C37	C1	Q8	B1	R39	B1	R78	A4	U3	B2-B3		
C38	B1	R1	B3	R40	A2	R79	A4	U4	C2		

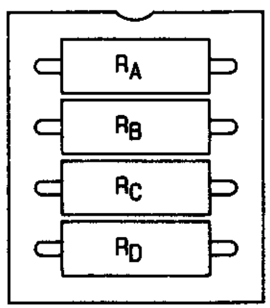
597-0032-38

FIGURE 3-5. APC MAIN CIRCUIT BOARD COMPONENT LOCATOR

A



B



HEADER, 8 PIN

RESISTOR NETWORK ASSEMBLY	RESISTOR NETWORK No.	OHMS RESISTANCE			
		R_A	R_B	R_C	R_D
959-1000-023	R82	390K	5.1K	1K	180
959-1000-008	R86	4.7K	470	4.7K	10K
959-1000-009	R89	10M	2.7K	2.4K	22K
959-1000-025	R96	UNUSED	270	100	7.5K

597-0098-35

FIGURE 3-10. AUTOMATIC POWER CONTROL PROGRAM NETWORK

SECTION IV
APC PARTS LIST

4-1. INTRODUCTION.

4-2. This section provides descriptions and part numbers of electrical components, assemblies, and selected mechanical parts required for maintenance of the Broadcast Electronics FM-10A Automatic Power Control Unit. Each table entry in this section is indexed by reference designators appearing on the applicable schematic diagram.

TABLE 4-1. AUTOMATIC POWER CONTROL UNIT PARTS LIST INDEX

TABLE	DESCRIPTION	PART NO.	PAGE
4-2	AUTOMATIC POWER CONTROL UNIT ASSEMBLY	959-0243	4-2
4-3	POWER TRANSFORMER ASSEMBLY	376-7675-001	4-2
4-4	WIRE HARNESS ASSEMBLY	949-0038	4-2
4-5	MAIN CIRCUIT BOARD ASSEMBLY	919-0206	4-3
4-6	FRONT PANEL CIRCUIT BOARD ASSEMBLY	919-0028	4-5
4-7	REAR PANEL CIRCUIT BOARD ASSEMBLY	919-0207	4-6
4-8	AUTOMATIC POWER CONTROL JUMPER NETWORK ASSEMBLY	959-1001	4-7
4-9	REAR-PANEL CIRCUIT BOARD JUMPER ASSEMBLY, AUTOMATIC POWER CONTROL UNIT	959-0236	4-7
4-10	AUTOMATIC POWER CONTROL RESISTOR NETWORK ASSEMBLY	959-1000-023	4-7
4-11	AUTOMATIC POWER CONTROL RESISTOR NETWORK ASSEMBLY	959-1000-008	4-7
4-12	AUTOMATIC POWER CONTROL RESISTOR NETWORK ASSEMBLY	959-1000-009	4-7
4-13	AUTOMATIC POWER CONTROL RESISTOR NETWORK ASSEMBLY	959-1000-025	4-7

TABLE 4-2. AUTOMATIC POWER CONTROL ASSEMBLY - 959-0243

REF. DES.	DESCRIPTION	PART NO.	QTY.
BT1	Battery, 9 Volt, Alkaline	350-0002	1
DS1 THRU DS5	Lamp, No. 73, 14V, 0.08A, T-1 3/4 Bulb, Wedge Base	320-0007	5
F1,F2, SPARE	Fuse, 250V, 1/2 Ampere, AGC	330-0050	3
FL1	RFI Line Filter, 250V ac, 3 Ampere Maximum, 50/60 Hz	339-0008	1
J9,J10,J12	Receptacle, BNC, Insulated	417-0016	3
MOV 1	Metal Oxide Varistor, V250LA15A, 250V ac RMS, 15 Joules	140-0008	1
R16	Potentiometer, 10 k Ohm ±10%, 1W (VSWR CAL)	192-1052	1
S6	Rocker Switch, DPDT, 5A @ 120V ac or 28V dc Resistive Load or 2A @ 250V ac, Resistive Load (FWD/VSWR/VSWR CAL)	340-0021	1
S1 THRU S5	Push Switch, Momentary, Illuminated, SPDT, 3A @ 125V ac Maximum, Gold Contacts (REMOTE DISABLE, PRESET, APC ON, LOWER and RAISE)	340-0015-001	5
XF1,XF2	Fuse Holder, AGC	415-2012	2
----	Turn-Lock Fastener, Stud, Rear	420-0027	1
----	Turn-Lock Fastener, Stud, Front and Sides	420-0019	5
----	Stud Retainer, Split Ring	420-0021	6
----	Receptacle, Turn-Lock Fastener	420-0022	6
----	Power Transformer Assembly	376-7675-001	1
----	Rear-Panel Circuit Board Jumper Assembly, Automatic Power Control Unit	959-0236	1
----	Wire Harness Assembly	949-0038	1
----	Main Circuit Board Assembly	919-0206	1
----	Front Panel Circuit Board Assembly	919-0028	1
----	Rear Panel Circuit Board Assembly	919-0207	1
----	Chassis Slides	469-0413-002	1
----	Magnet for Latch	488-0002	2
----	Clips for Spare Line Fuse	415-1001	2
----	Knob, Black, 1/4 inch ID (0.635 cm) for VSWR CAL Control	481-0014	1
----	Lens, Gray, for LOWER and RAISE Switch/Indicators	340-0022	2
----	Lens, Yellow, for PRESET and REMOTE DISABLE Switch/Indicators	340-0014	2
----	Lens, Green, for APC ON Switch/Indicator	340-0019	1

TABLE 4-3. POWER TRANSFORMER ASSEMBLY - 376-7675-001

REF. DES.	DESCRIPTION	PART NO.	QTY.
P1	Plug, 6-Pin	418-0670	1
----	Pins for P1	417-0053	6
T1	Transformer, Power Dual Primary: 120V, 50/60 Hz Dual Secondary: 25V @ 1.0 Ampere	376-7675	1

TABLE 4-4. WIRE HARNESS ASSEMBLY - 949-0038

REF. DES.	DESCRIPTION	PART NO.	QTY.
P3	Connector, Housing, 25-Pin In-line	417-0163	1
P4	Connector, Housing, 26-Pin In-line	417-0164	1
P5	Connector, Housing, 14-Pin In-line	417-1401	1
P6	Connector, Housing, 17-Pin In-line	417-0162	1
P7	Connector, Housing, 4-Pin In-line	417-0138	1
----	Pins, Receptacle (for Connectors P3, P4, P5, P6, and P7)	417-0053	83

TABLE 4-5. MAIN CIRCUIT BOARD ASSEMBLY - 919-0206
(Sheet 1 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C10	Capacitor, Mylar, 0.1 uF, 100V	030-1053	10
C11	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C12	Capacitor, Mylar, 0.1 uF, 100V	030-1053	1
C13,C14	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
C15	Capacitor, Electrolytic, 4.7 uF, 35V	024-4753	1
C17,C18	Capacitor, Poly Film, 0.0022 uF ±10%, 100V	031-2033	2
C19	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C20 THRU C22	Capacitor, Mylar, 0.1 uF, 100V	030-1053	3
C23	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C24 THRU C32	Capacitor, Mylar, 0.1 uF, 100V	030-1053	9
C33,C34	Capacitor, Electrolytic, 47 uF, 35V	024-4753	2
C35	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	1
C36	Capacitor, Electrolytic, 4.7 uF, 35V	024-4753	1
C37,C38	Capacitor, Mylar, 0.1 uF, 100V	030-1053	2
C39	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
D1 THRU D3	Diode, 1N4148, Silicon, 75V, 0.3 Ampere	203-4148	3
D4,D5	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	2
D6 THRU D16	Diode, 1N4148, Silicon, 75V, 0.3 Ampere	203-4148	11
D17	Diode, 1N4733A, Zener, 5.1V, 1W	200-4733	1
DS1	Indicator, LED, Green, 521-9175, 3V @ 40 mA Maximum	323-9224	1
DS2 THRU DS5	Indicator, LED, Red, 521-9212, 2V @ 50 mA Maximum	323-9217	4
J4	Receptacle, Header, 20-Pin In-line	417-0200	1.3
J5	Receptacle, Header, 20-Pin In-line	417-0200	.70
J11	Socket, 16-Pin DIP	417-1604	1
J12 THRU J15	Receptacle, Header, 3-Pin	417-0003	4
P12 THRU P15	Jumper, Programmable	340-0004	4
Q1	Transistor, MPS-U45, Silicon, NPN, Darlington	210-0045	1
Q2	Transistor, MPS-U95, Silicon, PNP, Darlington	210-0095	1
Q3	Transistor, MPS-U45, Silicon, NPN, Darlington	210-0045	1
Q4	Transistor, MPS-U95, Silicon, PNP, Darlington	210-0095	1
Q5	Transistor, MPS-A14, Silicon, NPN, Darlington, TO-92 Case	211-0014	1
Q6 THRU Q8	Transistor, 2N3906, Silicon, PNP, TO-92 Case	210-3906	3
R1	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R2	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R3 THRU R9	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	7
R10	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R11 THRU R19	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	9
R20,R21	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	2
R22	Resistor, 1.2 k Ohm ±5%, 1/4W	100-1243	1
R23 THRU R25	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	3
R26	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R27 THRU R30	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	4
R31,R32	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	2
R33,R34	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R35	Resistor, 150 k Ohm ±5%, 1/4W	100-1563	1
R38	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R39	Resistor, 2 k Ohm ±5%, 1/4W	100-2043	1
R40	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R41	Resistor, 910 Ohm ±5%, 1/4W	100-9133	1
R42	Potentiometer, 50 k Ohm ±10%, 1/2W (FWD CAL)	177-5050	1
R43	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R44	Potentiometer, 100 k Ohm ±10%, 1/2W (RFL CAL)	177-1065	1
R45	Resistor, 910 Ohm ±5%, 1/4W	100-9133	1
R46,R47, R49	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	3
R51	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R52	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R53	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1

TABLE 4-5. MAIN CIRCUIT BOARD ASSEMBLY - 919-0206
(Sheet 2 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R54	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R55	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R56	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R57	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R58	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R59	Resistor, 2.2 Meg Ohm ±5%, 1/4W	100-2273	1
R60,R61	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	2
R62	Resistor, 470 k Ohm ±5%, 1/4W	100-4763	1
R63 THRU R68	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	6
R69	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R72	Resistor, 1.3 Meg Ohm ±5%, 1/4W	100-1373	1
R73	Resistor, 634 k Ohm ±1%, 1/4W	103-6346	1
R74	Resistor, 324 k Ohm ±1%, 1/4W	103-3246	1
R75	Resistor, 162 k Ohm ±1%, 1/4W	103-1626	1
R76	Resistor, 80.6 k Ohm ±1%, 1/4W	103-8065	1
R77	Resistor, 40.2 k Ohm ±1%, 1/4W	103-4025	1
R78	Resistor, 20 k Ohm ±1%, 1/4W	103-2051	1
R79	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R80	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R81	Resistor, 390 k Ohm ±5%, 1/4W	100-3963	1
R83	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	1
R84	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R87	Potentiometer, 5 k Ohm ±10%, 1/2W (PRESET CAL)	177-5044	1
R90	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R91	Resistor, 10 k Ohm ±1%, 1/4W	100-1051	1
R92	Resistor, 115 Ohm ±1%, 1/4W	100-1131	1
R93	Resistor, 1 k Ohm ±1%, 1/4W	103-1041	1
R94	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	1
R99	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R100,R101	Resistor, 390 k Ohm ±5%, 1/4W	100-3963	2
R102	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
R103	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	1
R104 THRU R107	Resistor, 1.2 k Ohm ±5%, 1/4W	100-1243	4
R108	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	1
R109,R110	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R111	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R112	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R113	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
U1	Integrated Circuit, CD4050BCN, Hex Non-Inverting Buffer, 16-Pin DIP	228-4050	1
U2	Integrated Circuit, 4N33, Infrared LED, Photo Darlington, 6-Pin DIP	229-0033	1
U3,U4	Integrated Circuit, CD4027BE, Dual J-K Flip-Flop, 16-Pin DIP	225-0003	2
U5,U6	Integrated Circuit, 4N33, Infrared LED, Photo Darlington, 6-Pin DIP	229-0033	2
U7	Integrated Circuit, MC14001B, Quad 2-Input NOR Gate, 14-Pin DIP	228-4001	1
U8	Integrated Circuit, MC14002B, Dual 4-Input NOR Gate, 14-Pin DIP	228-4002	1
U9	Integrated Circuit, CD4069CN, Inverter, CMOS, 14-Pin DIP	228-4069	1
U10	Integrated Circuit, MC14001B, Quad 2-Input NOR Gate, 14-Pin DIP	228-4001	1
U11	Integrated Circuit, MC1416, Seven Darlington Peripheral Drivers, 16-Pin DIP	226-2004	1
U12	Integrated Circuit, MC14011B, Quad 2-Input NAND Gate, 14-Pin DIP	228-4011	1
U13	Integrated Circuit, CD4066BE, Quad Bilateral Switch, 14-Pin DIP	225-0004	1
U14	Integrated Circuit, CD4019AE, Quad AND/OR Select Gate, 16-Pin DIP	228-4019	1
U15	Integrated Circuit, MC1416, Seven Darlington Peripheral Drivers, 16-Pin DIP	226-2004	1
U16	Integrated Circuit, 4047B, Monostable/Astable Multivibrator, CMOS, 14-Pin DIP	220-4047	1

TABLE 4-5. MAIN CIRCUIT BOARD ASSEMBLY - 919-0206
(Sheet 3 of 3)

REF. DES.	DESCRIPTION	PART NO.	QTY.
U17	Integrated Circuit, MC14011B, Quad 2-Input NAND Gate, 14-Pin DIP	228-4011	1
U18,U19	Integrated Circuit, LM358N, Low Power, Dual Operational Amplifier, 8-Pin DIP	221-0358	2
U20	Integrated Circuit, CD4069CN, Inverter, CMOS, 14-Pin DIP	228-4069	1
U21	Integrated Circuit, 14 Stage Counter, CMOS, 16-Pin DIP	228-4020	1
U22	Integrated Circuit, CD4012, Dual 4-Input NAND Gate, 14-Pin DIP	228-4012	1
U23,U24	Integrated Circuit, MC14516B, Binary Up/Down Counter, CMOS, 16-Pin DIP	228-4516	2
U25,U26	Integrated Circuit, CD4050BC, Hex Non-Inverting Buffer, 16-Pin DIP	228-4050	2
U27 THRU U29	Integrated Circuit, LM358, Low Power Dual Operational Amplifier, 8-Pin DIP	221-0358	3
U30	Integrated Circuit, LM317T, Positive 3-Terminal Adjustable Voltage Regulator, 1.2V-37V, 1.5A Maximum, TO-220 Case	227-0317	1
U31,U32	Integrated Circuit, LM358, Low Power Dual Operational Amplifier, 8-Pin DIP	221-0358	2
U33	Integrated Circuit, MC14002B, Dual 4-Input NOR Gate, 14-Pin DIP	228-4002	1
U34	Integrated Circuit, MC14001B, Quad 2-Input NOR Gate, 14-Pin DIP	228-4001	1
XR82,XR86, XR89,XR96	Socket, 8-Pin DIP	417-0088	4
XU1	Socket, 16-Pin DIP	417-1604	1
XU2	Socket, 6-Pin DIP	417-0600	1
XU3,XU4	Socket, 16-Pin DIP	417-1604	2
XU5,XU6	Socket, 6-Pin DIP	417-0600	2
XU7 THRU XU10	Socket, 14-Pin DIP	417-1404	4
XU11	Socket, 16-Pin DIP	417-1604	1
XU12,XU13	Socket, 14-Pin DIP	417-1404	2
XU14,XU15	Socket, 16-Pin DIP	417-1604	2
XU16,XU17	Socket, 14-Pin DIP	417-1404	2
XU18,XU19	Socket, 8-Pin DIP	417-0804	2
XU20	Socket, 14-Pin DIP	417-1404	1
XU21	Socket, 16-Pin DIP	417-1604	1
XU22	Socket, 14-Pin DIP	417-1404	1
XU23 THRU XU26	Socket, 16-Pin DIP	417-1604	4
XU27 THRU XU29,XU31, XU32	Socket, 8-Pin DIP	417-0804	5
XU33,XU34	Socket, 14-Pin DIP	417-1404	2
----	Holder, Battery	415-0002	1
----	Blank Circuit Board	519-0027	1

TABLE 4-6. FRONT PANEL CIRCUIT BOARD ASSEMBLY - 919-0028
(Sheet 1 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
D1,D2	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	2
J6	Receptacle, Header, 20-Pin In-line	417-0200	.8
J7	Receptacle, Header, 20-Pin In-line	417-0200	.2
R1	Resistor, 23.2 k Ohm ±1%, 1/4W	103-2325	1
R2	Resistor, 4.75 k Ohm ±1%, 1/4W	103-4741	1
R3	Resistor, 5.11 k Ohm ±1%, 1/4W	103-5141	1
R4	Resistor, 9.31 k Ohm ±1%, 1/4W	103-9314	1
R5	Resistor, 3.65 k Ohm ±1%, 1/4W	103-3641	1
R6	Resistor, 20 Ohm ±5%, 1/4W	100-2023	1
R7	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R8	Resistor, 20 Ohm ±5%, 1/4W	100-2023	1
R9	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R10	Resistor, 20 Ohm ±5%, 1/4W	100-2023	1

TABLE 4-6. FRONT PANEL CIRCUIT BOARD ASSEMBLY - 919-0028
(Sheet 2 of 2)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R11	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R12	Resistor, 20 Ohm ±5%, 1/4W	100-2023	1
R13	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R14	Resistor, 20 Ohm ±5%, 1/4W	100-2023	1
R15	Resistor, 1.8 k Ohm ±5%, 1/4W	100-1843	1
R17	Potentiometer, 5 k Ohm ±10%, 1/2W	178-5043	1
----	Blank Circuit Board	519-0028	1

TABLE 4-7. REAR PANEL CIRCUIT BOARD ASSEMBLY - 919-0207

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C5, C7 THRU C13,C15, C17 THRU C21, C23 THRU C33	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	29
C34	Capacitor, Electrolytic, 470 uF, 50V	024-4783	1
C35,C36	Capacitor, Electrolytic, 3.3 uF, 50V	020-3363	2
C37 THRU C45	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	9
C46,C47	Capacitor, Electrolytic, 3.3 uF, 50V	020-3363	2
C48 THRU C56	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	9
C57,C58	Capacitor, Electrolytic, 100 uF, 50V	020-1083	2
C59,C60	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	2
D1 THRU D4	Diode, HP5082-2800, Silicon, High Voltage Schottky Barrier Type, 70V, 15 mA	201-2800	4
D5 THRU D13	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	9
D14,D15	Diode, 1N6276A, Silicon, Transient Voltage Suppressor, 16V ±0.05% Breakdown	206-6276	2
D16,D17	Diode, Zener, 1N4739A, 9.1V ±5%, 1W	200-0009	2
F1,F2	Fuse, 3 AG, 1 Ampere	330-0100	2
J1,J2	Receptacle, 6-Pin	417-0677	2
J3	Receptacle, 20-Pin, In-line	417-0200	1.3
J8	Receptacle, 25-Pin	417-2500	1
J11	Receptacle, 20-Pin In-line (Jumper in place of DAC circuit board used in FM-1.5A only)	417-0200	.70
L1 THRU L10	Choke, 4.7 uH ±10%, 430 mA, dc Resistance = 0.55 Ohms	360-0022	10
P11	Plug, Header, 14-Pin	417-6002-014	1
R1,R2	Resistor, 56 Ohm ±5%, 2W	130-5621	2
R3	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R4	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R5	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R7 THRU R12	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	6
R13,R14	Resistor, 470 Ohm ±5%, 1/4W	100-4733	2
R15,R16	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R17	Resistor, 68 Ohm ±5%, 2W	132-6832	1
R18	Resistor, 4.22 k Ohm ±1%, 1/4W	103-4224	1
R19 THRU R22	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	4
R24	Resistor, 115 Ohm ±1%, 1/4W	100-1131	1
R25	Resistor, 1.24 k Ohm ±1%, 1/4W	103-1244	1
R26	Resistor, 115 Ohm ±1%, 1/4W	100-1131	1
R27	Resistor, 1.24 k Ohm ±1%, 1/4W	103-1244	1
R28	Resistor, 150 Ohm ±1%, 1/4W	100-1531	1
R29	Resistor, 536 Ohm ±1%, 1/4W	103-5363	1
S1	Switch, Toggle, DPDT 5 Amperes, resistive load @ 120V ac/28V dc 2 Amperes, resistive load @ 250V ac	340-0012	1
U1,U2	Integrated Circuit, LM317K, Positive 3-Terminal Adjustable Voltage Regulator, 1.2V to 37V, 1.5A Maximum, TO-3 Case	227-0318	2
----	Fuse Clips	415-2068	4
----	Blank Circuit Board	519-0029	1

TABLE 4-8. ASSEMBLY, AUTOMATIC POWER CONTROL JUMPER NETWORK - 959-1001

REF. DES.	DESCRIPTION	PART NO.	QTY.
P11	Plug, Header, 16-Pin DIP	418-0030	1

TABLE 4-9. REAR-PANEL CIRCUIT BOARD JUMPER ASSEMBLY, AUTOMATIC POWER CONTROL UNIT - 959-0236

REF. DES.	DESCRIPTION	PART NO.	QTY.
P11	Connector, Housing, 14-Pin In-line	417-1401	1
----	Pins, Receptacle (for Connector P11)	417-8766	8

TABLE 4-10. ASSEMBLY, AUTOMATIC POWER CONTROL RESISTOR NETWORK - 959-1000-023

REF. DES.	DESCRIPTION	PART NO.	QTY.
PR82	Plug, Header, 8-Pin DIP	418-0112	1
R82A	Resistor, 390 k Ohm ±5%, 1/4W	100-3963	1
R82B	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	1
R82C	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R82D	Resistor, 180 Ohm ±5%, 1/4W	100-1833	1

TABLE 4-11. ASSEMBLY, AUTOMATIC POWER CONTROL RESISTOR NETWORK - 959-1000-008

REF. DES.	DESCRIPTION	PART NO.	QTY.
PR86	Plug, Header, 8-Pin DIP	418-0112	1
R86A	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R86B	Resistor, 470 Ohm ±5%, 1/4W	100-4733	1
R86C	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R86D	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1

TABLE 4-12. ASSEMBLY, AUTOMATIC POWER CONTROL RESISTOR NETWORK - 959-1000-009

REF. DES.	DESCRIPTION	PART NO.	QTY.
PR89	Plug, Header, 8-Pin DIP	418-0112	1
R89A	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R89B	Resistor, 2.7 k Ohm ±5%, 1/4W	100-2743	1
R89C	Resistor, 2.4 k Ohm ±5%, 1/4W	100-2443	1
R89D	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1

TABLE 4-13. ASSEMBLY, AUTOMATIC POWER CONTROL RESISTOR NETWORK - 959-1000-025

REF. DES.	DESCRIPTION	PART NO.	QTY.
PR96	Plug, Header, 8-Pin DIP	418-0112	1
R96B	Resistor, 270 Ohm ±5%, 1/4W	100-2733	1
R96C	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R96D	Resistor, 7.5 k Ohm ±5%, 1/4W	100-7543	1

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SECTION I

TRANSMITTER CONTROLLER THEORY OF OPERATION

1-1. INTRODUCTION.

1-2. The following text provides theory of operation with supporting diagrams for the FM-10A transmitter controller.

1-3. FUNCTIONAL DESCRIPTION.

1-4. Two levels of discussion are provided. A general discussion of the transmitter controller operation at block diagram level is followed by a detailed discussion of circuit operation.

1-5. GENERAL DESCRIPTION.

1-6. All status displays and most control functions in the FM-10A transmitter are implemented through use of a digital controller that monitors transmitter operation (see Figure 1-1). Using information collected throughout the transmitter, the controller will determine what control actions are required and complete these actions (such as timed intervals, overloads, or interlocks) without delay. The transmitter control logic will interface with most modern remote control devices and ATS units.

1-7. Information concerning overloads is presented by four front-panel indicators and stored for analysis after the problem has occurred to aid in problem resolution. Seven additional front-panel status indicators provide information relative to transmitter operation. Two internal LEDs indicate the transmitter power supply status and the controller overload and power-up memory battery status.

1-8. An optional diagnostic monitoring system utilizing a CRT display is available with the FM-10A transmitter. This microprocessor-based system continuously monitors and controls all major parameters of the transmitter and functions independently of the standard digital control circuit. Video displays of the transmitter operating conditions may be displayed in either an analog tabular chart format or a digital bargraph format. This system may be factory installed or field retrofitted to an existing FM-10A transmitter.

1-9. OPERATION.

1-10. The controller is constructed with solid-state digital circuitry on five circuit boards. The circuit boards are mounted within an enclosed chassis with a removable top for ease of maintenance. The RFI filter circuit board processes all inputs and outputs to minimize susceptibility to RF interference, the motherboard provides bus interconnections for the controller circuit board, and the controller circuit board provides logic functions. All the front-panel LED indicators are mounted on the front-panel indicator circuit board and all the front-panel switches are mounted on the front-panel switch circuit board. All operational potentials for the controller are provided by its own power supply. A fan ensures cool and reliable operation of the controller power supply.

1-11. Commands such as "filament on" and "high voltage on" are initiated by a momentary HIGH applied to conditional logic circuitry on the controller circuit board. A "one-button start" may be selected by depressing the HIGH VOLTAGE ON switch/indicator only. As each switch is depressed, the associated switch/indicator will illuminate to indicate that the selected command has been received and stored.

1-12. Assuming the FILAMENT ON and/or HIGH VOLTAGE ON switch/indicators have been depressed and all safety interlocks are closed, the blower will start. The safety-interlocks closed condition is signified by illumination of the front-panel INTERLOCK indicator.

1-13. When the air pressure switch closes, the BLOWER indicator will illuminate and the conditional logic will start the filament warm-up timer, apply filament voltage to the PA tube, and illuminate the FILAMENT indicator.

1-14. After the filament warm-up delay expires, if no overloads exist, all interlocks remain closed, and the air switch remains closed, a "high-voltage on" signal will be output to the high voltage step-start circuitry and remove the mute command from the FM exciter. The associated HIGH VOLTAGE indicator will illuminate to indicate that a "high voltage on command" has been output from the controller.

1-15. If the HIGH VOLTAGE OFF switch/indicator is depressed, a momentary HIGH applied to the conditional logic circuitry will deenergize the high voltage supply. When the FILAMENT OFF switch is depressed, a momentary HIGH applied to the conditional logic circuitry will deenergize the filament supply and initiate a filament cool-down interval. When the filament cool-down timer delay expires, the blower will deenergize. The FILAMENT OFF switch/indicator can be used to simultaneously deenergize both the plate and filament supplies if desired.

1-16. REMOTE CONTROL. Transmitter remote control is enabled whenever the automatic power control unit (APC) REMOTE DISABLE switch/indicator is not illuminated. Local control of the transmitter is possible at all times. The remote control inputs are routed through the controller RFI filter and coupled to the conditional logic circuitry in parallel with the local inputs through optical isolators. These optical isolators are enabled by a ground from the APC REMOTE DISABLE switch/indicator. Remote metering and status outputs are active at all times. A "one-button start" feature is incorporated as a remote control provision by using the high voltage on feature for one-button start and the filament off feature for one-button stop. All timing will be handled by the controller logic.

1-17. INTERLOCKS. If a safety interlock opens, the transmitter will deenergize immediately. The transmitter must be manually restored to operation after the open interlock is closed. The controller front-panel INTERLOCK indicator will go out to indicate an open interlock. If the opened safety interlock is closed before the filament cool-down timer interval expires, the blower will re-energize for the remaining duration of the cool-down cycle and then deenergize. If the air pressure interlock opens, the power supplies will deenergize immediately. When the interlock closes, the transmitter will return to operation automatically.

1-18. If the external interlock is opened, only the high voltage plate supply will be deenergized. The controller HIGH VOLTAGE STATUS indicator and the external interlock indicator (if installed) will extinguish to indicate an open interlock. When the external interlock is closed, the transmitter will return to operation automatically.

1-19. OVERLOADS. Plate current, screen current, control grid bias supply current, and PA reflected power are monitored for overload conditions. If an overload occurs, this information will be applied to the overload logic circuitry.

1-20. Any overload will illuminate the OVERLOAD indicator and initiate two timed intervals. A timer/counter pair monitors the number of times an overload occurs during a 60 second interval and the second timer delays restoration of the transmitter to operation to allow the condition that prompted the overload to dissipate.

1-21. When the timed interval delaying restoration of the transmitter to operation has expired, the transmitter will recycle back into operation. If no further overloads occur during the 60 second interval following the first overload, the 60 second timer will clear the overload counter. If four overload recycles occur during the 60 second counter/timer interval, the transmitter will deenergize and must be manually reset. This can be done by depressing the OVERLOAD switch/indicator, the FILAMENT ON switch/indicator, and the HIGH VOLTAGE ON switch/indicator. The overload can also be cleared by remote control if remote control is enabled by the APC REMOTE DISABLE switch/indicator.

1-22. If an overload persists in duration for longer than 0.22 seconds, the overload shut-down circuit will consider the overload a short circuit and immediately deenergize the transmitter. The transmitter must then be manually restored to operation after the fault is repaired.

1-23. DETAILED DESCRIPTION.

1-24. RFI FILTER CIRCUIT BOARD. All controller inputs and outputs are routed through connectors J1, J2, and J3 mounted to the RFI filter circuit board. The circuitry consists of single PI-section low-pass RC and LC filters effective to 108 MHz and connected in series with each input and output to prevent RF leakage into the controller. The filter circuit board also contains the following programmable circuitry: 1) inverter arrays U1 and U2 which determines the remote status indication logic, 2) resistor network R35 which functions as a voltage divider to reduce the remote meter indications to +2.5V dc, and 3) jumper J7 which selects either independent or safety external interlock operation.

1-25. MOTHERBOARD. The motherboard provides a single 100-pin edge connector (J1) to mount the controller circuit board. Logic inputs and outputs to the motherboard are routed via ribbon cables and connected to J3 and J4. Power is connected to J2.

1-26. CONTROLLER CIRCUIT BOARD. Input latches U17A, U17B, and U17C are used to store the momentary contact closures representative of command inputs (see Figure 1-2). When the FILAMENT ON switch/indicator is depressed, a momentary LOW from NOR gate U9A will force the Q output of U17A HIGH. When the HIGH VOLTAGE ON switch/indicator is depressed, a momentary LOW from NOR gate U10A will force the Q output of U17B HIGH. A "one-button start" feature is provided by a connection from the Q output of U17B to U9A.

1-27. Blower On. The HIGH from the Q output of U17A is applied to the blower off delay circuit, analog switch U32, blower timer U23A and filament gate U19A. The blower off delay circuit has no function at transmitter turn-on. The input to analog switch U32 illuminates the FILAMENT ON switch/indicator to signify that the filament on command has been received and stored. A HIGH from the Q output of blower timer U23A will be applied to blower AND gate U26A through OR gate U24A. Assuming the safety interlocks remain closed, the remaining input to U26A will be HIGH and a HIGH will be output through analog switch U32 and optical isolator U38 to energize the blower control circuitry.

1-28. The output potential for optical isolator U38 is routed through the safety interlocks. If the safety interlock string opens, the blower control voltage will be disconnected and the safety interlock control logic will completely deenergize the transmitter.

1-29. Filament On. As the blower continues to operate, the air switch will close. The air switch closed signal is applied to optical isolator U6 which forces a HIGH from U12B and a LOW from U12C. The LOW from U12C is applied to inverter U18A which will output a HIGH to filament AND gate U19A. As the remaining input to U19A was set HIGH by the Q output of U17A, a HIGH will be output through analog switch U34 and optical isolator U37 to activate the filament circuit. The FILAMENT status indicator will illuminate to signify that the filament circuit is energized.

1-30. The output potential for optical isolator U37 is routed through the safety interlocks. If the safety interlock string opens, the filament control voltage will be disconnected and the safety interlock control logic will completely deenergize the transmitter.

1-31. High Voltage On. Assuming the HIGH VOLTAGE ON switch/indicator has been depressed, a HIGH from the Q output of U17B through analog switch U32 will illuminate the HIGH VOLTAGE ON switch/indicator to signify the high voltage on command has been received and stored. The previously set HIGH from U19A (the filament gate) will also be applied to the filament on delay and gate U14B.

1-32. If the ac power status input to U14B is HIGH, AND gate U14B will output a HIGH to start filament timer U23B. The output of U23B will start HIGH, go LOW for the duration of the filament heating delay, then return HIGH. The filament on delay circuit will hold a momentary LOW on high voltage gate U25A to prevent the time delay encountered in starting timer U23B from pulsing the high voltage circuit on, then off, then back on after the filament heating delay.

1-33. When the filament heating delay has expired and a HIGH from U19B signals that no overloads exist, U25A will output a HIGH to U34. U34 operating in conjunction with inverter U51C will output a LOW to step-start OR gate U24B. If a LOW from the external interlock circuit is present (indicating the interlock is closed), U24B will output a LOW to energize the step-start circuit.

1-34. The step driver will energize the plate supply step relay to apply primary voltage to the plate supply transformer through three limiting resistors. After a 100 millisecond delay determined by R149, C40, and U51D, the start driver will energize the start contactor and apply the full primary potential to the plate supply transformer. The step circuit will deenergize after being energized for 160 milliseconds, determined by R150, C41, and U51E. In this manner, the plate supply inrush is limited and the current limiting resistors are subject to heating only during a 100 millisecond interval before start contactor closure. For added reliability, the limiting resistors are disconnected after 160 milliseconds.

1-35. The exciter enable line and the HIGH voltage status indicator are wired in parallel from U39 with the start driver. Simultaneous with generation of the start signal, the exciter will be enabled and the HIGH VOLTAGE status indicator will illuminate to indicate that the plate supply control signal has been output. The high voltage supply is prevented from step-starting under full load in this manner.

1-36. The output potential for optical isolator U39 is routed through the safety interlocks. If the safety interlock string opens, the plate supply start control voltage will be disconnected and the safety interlock control logic will completely deenergize the transmitter.

1-37. Power-On Initialization. When power is initially first applied to the transmitter controller circuit board, the +15 volt input to inverter U18B through R98 will produce a LOW output from U18B which clears all timers and resets all latches to the off condition. Capacitor C13 will gradually charge from the +15 volt dc input through resistor R24. When the charge on C13 equals the 2 volt threshold established by D3, D4, and Q1, transistor Q1 will conduct and force a HIGH from inverter U18B which will terminate the power-on initialization. Q1 will remain conducting as long as power is continuously applied to the +15 volt input.

1-38. Initialization is also applied to inverter U12A. U12A outputs a HIGH which resets the overload status latch (U17) via U11A, resets the overload latches (U31A, U31B, U31C, and U31D), and resets the overload counter (U57) through inverter U12D. The HIGH from U12A is also applied through OR gate U13B to U9B and U10B to reset the filament latch and the high voltage latch.

1-39. Ac Power Monitor. A +12 volt dc input from the controller power supply is monitored for instantaneous loss of ac power information. This input to optical isolator U8 will drive transistor Q2 into conduction which illuminates the POWER indicator. U8 also forces a HIGH from U26B which signifies ac power is applied to the transmitter. A 25 millisecond delay connected to the second input of U26B will delay the HIGH from U26B to allow all logic adequate time to reset before signaling ac power has returned to normal.

1-40. The ac power status information from U26B is ANDed in U14A with the safety interlock status. If the safety interlocks are opened while ac power is energized, a HIGH from U14A will be applied through OR gate U13B to U9B and U10B to reset the filament latch and the high voltage latch.

1-41. When the output of U26B is LOW (ac power lost), several actions occur:

A. The filament restart delay timer (U29A) is set via U19D as soon as ac power is lost. If ac power is removed long enough for the filament restart delay timer interval to expire, U29A will reset the filament timer. When power returns, a new filament heating delay will be initiated before the plate supply is energized. If the ac power outage is momentary and U29A is not allowed to time out, high voltage will energize immediately upon restoration of ac power.

B. The overload comparators and latches will be inhibited by U30 as any inputs during power off will be false.

C. Additional circuitry inhibits the battery TEST indicator to conserve battery current, selects the A inputs to the analog switches for solid-state controller operation only, and advises the optional microprocessor controller of battery operation status.

1-42. The collector of Q2 routes power failure information to the optional microprocessor controller and provides a ground reference when ac power is on for SCREEN overload control R80, VSWR overload control R97, and battery test comparator U15A. During periods of battery operation, this same line routes a positive potential to the SCREEN overload and VSWR overload reference controls. This eliminates false overloads on ac power failure due to slowly decaying screen current and VSWR samples.

1-43. Safety Interlocks. The safety interlock circuitry consists of a series string of normally closed switches mounted in areas which contain electrical or mechanical hazards. Each switch is mechanically activated by a door or panel to deenergize the entire transmitter when opened. Logic states from the safety interlock circuitry are used in conditional logic for blower and filament turn on as described in the following text.

1-44. All outputs from the controller are routed through optical isolators. The output potential for the optical isolators is obtained from the series-wired safety interlock string. If an interlock opens, all output drivers from the controller circuit board will be disconnected. In addition, the safety interlock control logic input will be removed and the transmitter will completely deenergize.

1-45. The safety interlock closed information is input to optical isolator U7 and applied to inverter U12F as a LOW. When HIGH, the output of U12F will illuminate the INTERLOCK status indicator through analog switch U34 to signify the interlocks are closed and enable blower gate U26A.

1-46. The HIGH from U12F is also applied as a LOW to OR gate U13A and AND gate U14A through inverter U12E. OR gate U13A enables the filament gate (U19A) to allow filament turn-on. When both inputs to U13A are LOW, U13A will output a LOW to inverter U18A which applies a HIGH to the filament AND gate. This will occur whenever both the air pressure and the safety interlock switches are closed. AND gate U14A will produce the logical sum of a LOW from the safety interlock circuit and a HIGH from the ac power monitor circuit. If the safety interlocks are opened while ac power is applied to the transmitter, a HIGH through U13B will reset the filament latch via U9B and the high voltage latch via U10B to deenergize the transmitter. This will prevent the transmitter from re-energizing the filament or high voltage circuit upon closing the open interlock condition. Only the blower run-down timer (U23A) is allowed to continue operation.

1-47. External Interlock. The external interlock circuit is independent of the transmitter safety interlock circuit. External interlock closed information is applied to optical isolator U59 as a HIGH. The output of U59 will pull one input of step-start control OR gate U24B LOW, allowing a control pulse from U51C to enable the step-start circuitry. If the interlock is opened during transmitter operation, a HIGH is applied to U24B which disables the high voltage step-start circuit and deenergizes the plate supply.

1-48. Overload Input Circuit. Four parameters are monitored for overload conditions by the controller circuit board: screen current, control grid bias supply current, PA VSWR, and plate current. Each sample is input to a threshold comparator which converts the analog input to a digital state. Depending upon the polarity of the sample, the input is applied to the inverting or non-inverting input of the comparator. Resistors R92 and R72 on the plate sample and R79 on the screen sample form voltage dividers with the series input resistors (R93, R73, and R74) to convert the negative samples to positive voltages for the comparators. An adjustable threshold is established on the remaining input to each comparator. When the sample crosses the preset threshold, the output will switch from a LOW to a HIGH to signal an overload condition. The grid bias supply current overload trips on excessive supply current such as a short circuit in the tube socket.

1-49. Two comparators are used to monitor the plate current sample. The slower overload comparator (U20A) monitors for gradual increases such as mistuning which can draw up to two times normal plate current. The plate arc comparator (U22A) is a faster operating circuit that monitors for high-level short-duration arcs which will not trigger U20A. The two plate overload comparators are ORed in U24C. A HIGH from U24C signals a plate overload.

1-50. All five comparators normally output a LOW and switch to a HIGH to signal an overload condition. This logic is used as inputs for the overload display as well as the overload control circuitry.

1-51. Overload Diagnostics. For diagnostic display purposes, the output of each comparator is ANDed with a comparator enable signal and latched into a bistable flip-flop. Immediately after an overload is latched, the display enable signal will go LOW and inhibit further inputs. Until cleared with the overload RESET switch, no further overload information will be accepted for diagnostic display purposes. Any overload will be output from the latches as a HIGH through analog switch U33 for display as a diagnostic indication.

1-52. The overload latch (U17C) is set by a LOW from inverter U18D. A HIGH from the Q output of U17C will illuminate the OVERLOAD switch/indicator to signify that an overload has occurred. The HIGH from U17C is also inverted by U27E and ANDed in U14C with the ac power status to disable the overload latches (U31A, U31B, U31C, and U31D) through U30A, U30B, U30C, and U30D, inhibiting further overload inputs to the latches. The overload latch that was set by the overload input will illuminate its respective front-panel indicator via U33.

1-53. The overload display reset sequence is initiated by a positive potential which resets overload status latch U17C through NOR gate U11A. When U17C is reset, several actions occur:

A. The OVERLOAD reset switch/indicator and the overload diagnostic indicator (PLATE, SCREEN, GRID, or VSWR) indicator will go out.

B. The overload display latches (U31A, U31B, U31C, and U31D) will be reset.

C. The inhibit from U14C will be removed from the overload display gates.

D. The overload counter will be cleared via inverter U12D and OR gate U13D.

1-54. Overload Control Circuits. The overload control circuit inputs are obtained from the overload comparators. This circuit is not inhibited by a single overload as is the overload display circuit. The logical output of each comparator is ORed in U11B, routed through inverter U27F, and ANDed with the ac power status in U14D. An output from U14D is applied as a HIGH to overload shutdown timer U28B. This timer measures the duration of the high overload signal. If it is greater than 220 milliseconds, it applies a signal through U19C and U13C to deenergize filament latch U17A via U9B. This same HIGH is routed through inverter U18D and applied as a LOW to enable the overload counter reset timer (U28A), enable the overload recycle interval timer (U29B), and set the overload status latch (U17C).

1-55. The overload recycle interval timer (U29B) determines the length of time the transmitter remains off-the-air after an overload to allow the condition that prompted the overload to dissipate. Timer U29B can be adjusted from 0.1 to 2 seconds using R67. The overload counter (U57) counts the overload recycle attempts and the overload counter reset timer (U28A) resets the overload counter 60 seconds after the first overload occurred.

1-56. Each overload will initiate a recycle by deenergizing high voltage via AND gates U19B and U25A to attempt to clear the overload. The overload counter (U57) will count each recycle attempt. If four overloads occur within the 60 second interval of U28A, OR gate U13C will output a HIGH. This HIGH is applied to OR gate U9B which resets the filament latch (U17A) and deenergize the transmitter.

1-57. If an overload cycles the transmitter off-the-air and removing high voltage does not clear the overload after 220 milliseconds, the overload shutdown timer (U28B) will output a HIGH. This HIGH is ANDed in U19C with a HIGH from inverter U18C and signals overload shutdown through OR gate U13C.

1-58. Turn Off. The high voltage off sequence is initiated by a positive potential which resets the high voltage latch (U17B) through NOR gate U10B. When U17B is reset, the following actions will occur:

A. The HIGH VOLTAGE ON switch/indicator will go out.

B. A LOW via U19B and U25A will deenergize the plate power supply and the HIGH VOLTAGE status indicator will go out.

1-59. The filament off sequence is initiated by a positive potential which resets the filament latch (U17A) through NOR gate U9B. When U17A is reset, the following actions will occur:

A. The plate latch (U17B) will be reset by U10B via U9B.

B. The FILAMENT ON switch/indicator will go out.

C. A LOW via U19A will deenergize the filament supply and the FILAMENT status indicator will go out.

D. The blower timer (U23A) will begin time-down operation. The blower-off delay circuit composed of U18E, U18F, C30, and R99 will hold a momentary HIGH through U24A on blower gate U26A to prevent the time delay encountered in starting timer U23A from pulsing the blower off, then on, then back off after the blower run-down delay.

E. When the blower ceases operation, the BLOWER status indicator will go out.

1-60. Remote Control. The transmitter can be controlled by momentary positive-polarity dc inputs to the controller circuit board. Positive-logic enabled remote inputs are used for safety. Each remote input is routed through an optical isolator for isolation. Additional resistance to noise interference is provided by an RC circuit in each remote input. Diodes across each optical isolator input and diode D19 prevent possible damage to the remote circuitry caused by inadvertent connection to negative polarity control inputs. A +15 volt output is provided for remote operation, however the optical isolators can operate on any positive dc voltage from +5 volts to +24 volts.

1-61. The remote circuitry is enabled by a ground through the REMOTE ENABLE/DISABLE switch which enables the optically-isolated inputs. The input of this switch is connected to a pull-up resistor (R16) as a safety consideration to prevent remote operation in case the switch input were to become disconnected.

1-62. Remote PA Metering. The remote meter amplifiers for transmitter forward power, PA plate current, and PA plate voltage are mounted on the controller circuit board.

1-63. U15B is a non-inverting voltage amplifier with a gain of approximately one used for transmitter forward power. The input is obtained from the forward power buffer in the automatic power control unit. The output is clamped with a 15 volt zener diode for circuit protection. Positive five volts output corresponds to 100% power.

1-64. U16A is an inverting voltage amplifier with a gain of approximately 12. The input is obtained from one end of a resistor in the negative side of the plate power supply. As the plate current varies with power, R55 is included for level adjustment. Positive five volts output can be obtained by varying R55. The output is clamped with a 15 volt zener diode for circuit protection.

1-65. U16B functions as a non-inverting amplifier with a gain of one. The input is obtained from the low-potential end of the plate meter multiplier circuit board. Positive five volts corresponds to full-scale plate voltage.

1-66. POWER SUPPLY CIRCUIT BOARD. AC power is input to the controller through a voltage range selector which additionally provides overload protection and RFI isolation for the ac input (see Figure 1-3). A special power transformer with a tapped dual primary allows operation from both 50 and 60 Hz and a wide range of ac voltages without component changes. The primary and secondary windings are electrostatically shielded from each other. The secondary windings of the transformer produce three ac potentials which are full-wave rectified and regulated into four dc sources which supply all operating voltages for the exciter circuitry. When power is applied to the controller, the cooling fan will run continuously.

1-67. <u>Positive Fifteen Volt Controller Supply</u>. A 20.4 volt secondary of transformer T1 is full-wave bridge-rectified into a +27.5 volt supply by diodes D1, D2, D7, and D8 and filtered by capacitor C1. This rectified voltage is routed to U1 which regulates the input potential to a +15 volt source for the controller logic circuitry. The output potential is adjusted by R3. Diode D19 prevents capacitor and battery discharge through the regulator biasing circuit during power failures. Test point TP1 provides a convenient point to check operation of the supply.

1-68. Integrated circuit U1 is a three-terminal adjustable positive regulator containing internal thermal overload protection and short-circuit current limiting features. Further protection for U1 is provided by diode D16 which protects the regulator from a reverse polarity potential applied to the output.

1-69. The 15 volt potential is routed to the controller circuit board to provide operating potentials for the logic circuitry. Fuse F1 provides overload protection and diode D12 limits transients on the supply to 15.2 volts. Diodes D1 and D13 are steering diodes which isolate the 9 volt battery from the 15 volt supply and allow the battery to be tested while the circuit operates from the 15 volt input. In case of power failures, the 15 volt supply will be maintained at 9 volts by current flow through D1 and D13 to allow transmitter restoration to proceed automatically. Battery drain is approximately six milliamperes which allows three days of memory. The battery is not maintained on charge and must be replaced when discharged.

1-70. <u>Positive Twelve Volt AC Loss-of-Power Supply</u>. A 17.6 volt secondary (open-circuit voltage) of transformer T1 is full-wave bridge-rectified into a +12 volt supply by diodes D5, D6, D11, and D12 and filtered by capacitor C3. This potential is routed to optical isolator U8 on the controller circuit board for loss of ac power information. Test point TP4 provides a convenient point to check operation of the supply.

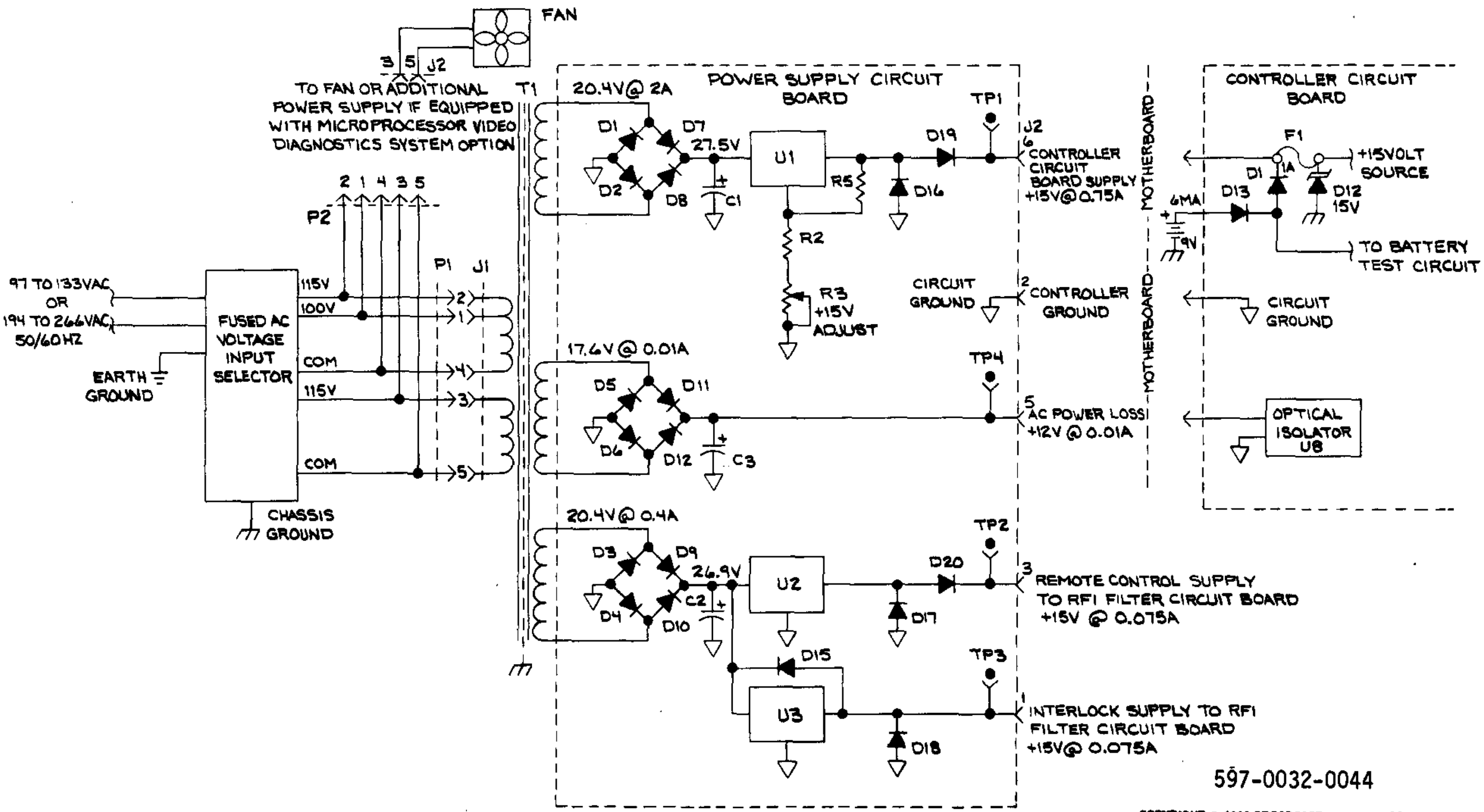


FIGURE 1-3. CONTROLLER POWER SUPPLY SIMPLIFIED SCHEMATIC

1-71. <u>Positive Fifteen Volt Remote Control Supply</u>. A 20.4 volt secondary of transformer T1 is full-wave bridge-rectified into a +27 volt supply by diodes D3, D4, D9, and D10 and filtered by capacitor C1. This rectified voltage is routed to U2 which regulates the input potential to a +15 volt source for the remote control circuitry. Diode D20 prevents capacitor discharge through the regulator during power failures. Test point TP2 provides a convenient point to check operation of the supply.

1-72. Integrated circuit U2 is a three-terminal fixed positive regulator containing internal thermal overload protection and short-circuit current limiting features. Further protection for U2 is provided by diode D17 which protects the regulator from a reverse polarity potential applied to the output.

1-73. <u>Positive Fifteen Volt Interlock Supply</u>. The input to regulator U3 is paralleled from the same +27 volt supply as regulator U2. Test point TP3 provides a convenient point to check operation of the supply.

1-74. Integrated circuit U3 is a three-terminal fixed positive regulator containing internal thermal overload protection and short-circuit current limiting features. Further protection for U3 is provided by diode D18 which protects the regulator from a reverse polarity potential applied to the output and diode D15 which protects the regulator from a short circuit on the regulator input.

SECTION II

TRANSMITTER CONTROLLER MAINTENANCE

2-1. INTRODUCTION.

2-2. This section provides maintenance information for the FM-10A transmitter controller.

2-3. SAFETY CONSIDERATIONS.

2-4. The FM-10A transmitter contains high voltages and currents which, if regarded carelessly, could be fatal. The transmitter has many built-in safety features, however good judgement, care, and common sense are the best accident preventives. The maintenance information contained in this section should be performed only by trained and experienced maintenance personnel.

2-5. MAINTENANCE.

WARNING NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

WARNING
WARNING
WARNING
WARNING
DUE TO THE PROGRAMMING OF THE EQUIPMENT, THE APC UNIT WILL ENTER THE REMOTE ENABLED MODE WHENEVER AC POWER IS APPLIED. TO PREVENT INADVERTENT REMOTE START-UP DURING MAINTENANCE PERIODS, DISCONNECT POWER FROM THE TRANSMITTER AND INSTALL JUMPER P14 ON THE APC UNIT MAIN CIRCUIT BOARD IN POSITION 1-2.

2-6. The FM-10A maintenance philosophy consists of preventative maintenance such as cleaning applied to the equipment of forestall future failures and second level maintenance consisting of procedures required to restore the equipment to operation after a fault.

2-7. ADJUSTMENTS.

WARNING NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED.

2-8. The following text provides procedures to adjust all controls associated with the transmitter controller. Adjustment procedures for each control are presented in the following order.

A. Controller circuit board control adjustment.

B. Power supply circuit board control adjustment.

2-9. CONTROLLER CIRCUIT BOARD CONTROL ADJUSTMENT.

2-10. VSWR OVERLOAD THRESHOLD ADJUST (R88). To adjust the VSWR overload control on the controller circuit board, proceed as follows.

2-11. Required Equipment. The following equipment is required to adjust the VSWR overload control (R88).

A. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

2-12. Procedure. To adjust the control, proceed as follows.

2-13. Refer to Figure 2-1 and adjust the VSWR overload threshold adjust control (R88) fully clockwise.

2-14. Operate the transmitter at the normal power output with the APC on.

2-15. Operate the OUTPUT POWER METER switch to FWD. Assure the OUTPUT POWER meter indicates 100%.

2-16. Operate the OUTPUT POWER METER switch to VSWR CAL and adjust the VSWR CAL control to obtain an OUTPUT POWER meter indication of 100%.

2-17. Depress the HIGH VOLTAGE OFF switch/indicator.

2-18. When the LOWER switch/indicator stops flashing, depress the APC ON and FILAMENT OFF switch indicators.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-19. Disconnect all transmitter primary power.

2-20. Disconnect cable No. 626 from the output directional coupler RFL port and connect the cable to the MON port.

CAUTION
CAUTION
CAUTION

ADJUSTMENT OF THE OVERLOAD CONTROLS DETERMINES AT WHAT POINT THE CONTROLLER WILL INITIATE ACTION. IF A CONTROL IS INCORRECTLY ADJUSTED, THE CONTROLLER MAY NOT SENSE A FAULT AND DAMAGE TO THE TRANSMITTER MAY RESULT.

2-21. Energize the transmitter primary ac power and depress the FILAMENT ON and HIGH VOLTAGE ON switch/indicators.

2-22. Verify that the OUTPUT POWER METER switch is set to VSWR and the APC ON switch/indicator is not illuminated.

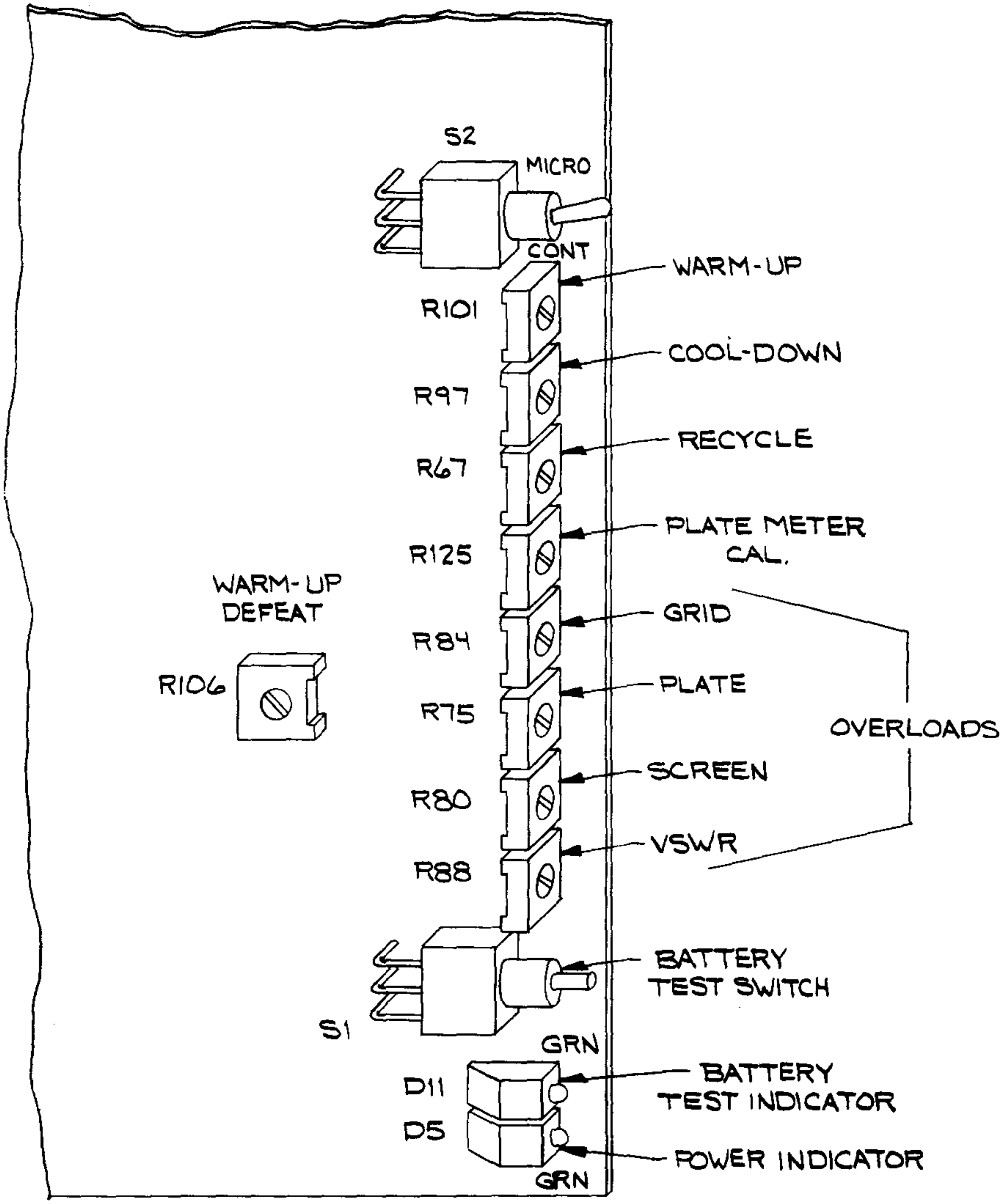


FIGURE 2-1. CONTROLLER CIRCUIT BOARD CONTROLS

2-23. Raise power manually by depressing the RAISE switch/indicator until the OUTPUT POWER meter indicates a VSWR of 3 : 1.

2-24. Refer to Figure 2-1 and adjust R88 until the VSWR indicator and the OVERLOAD RESET switch/indicator illuminate and the transmitter cycles off.

2-25. Depress the LOWER switch/indicator to lower the transmitter power, then depress the OVERLOAD RESET switch/indicator.

2-26. Depress the RAISE switch/indicator to raise power. The transmitter will cycle off at a VSWR indication of 3 : 1. If not, repeat the adjustment.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-27. Disconnect all transmitter primary power.

CAUTION

CAUTION

ENSURE CABLE NO. 626 IS RECONNECTED TO THE OUTPUT DIRECTIONAL COUPLER RFL PORT IN THE FOLLOWING STEP OR DAMAGE TO THE TRANSMITTER COULD RESULT.

2-28. Reconnect cable No. 626 to the RFL port in the output directional coupler.

2-29. GRID (R84), PLATE (R75), AND SCREEN (R80) OVERLOAD ADJUSTMENTS. To adjust the GRID, PLATE, and SCREEN overload controls on the controller circuit board, proceed as follows.

2-30. Required Equipment. The following equipment is required to adjust the GRID (R84), PLATE (R75), and SCREEN (R80) overload controls.

A. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

2-31. Procedure. To adjust the controls, proceed as follows. If more than one overload control is to be adjusted, the controls must be adjusted in a specific sequence: VSWR, PLATE, SCREEN, and GRID. The VSWR control is adjusted in paragraph 2-10.

2-32. Assure the APC ON switch/indicator is not illuminated.

2-33. Apply power and operate the transmitter within specifications at the rated RF output into a proper 50 Ohm load.

CAUTION

CAUTION

CAUTION

ADJUSTMENT OF THE OVERLOAD CONTROLS DETERMINES AT WHAT POINT THE CONTROLLER WILL INITIATE ACTION. IF A CONTROL IS INCORRECTLY ADJUSTED, THE CONTROLLER MAY NOT SENSE A FAULT AND DAMAGE TO THE TRANSMITTER MAY RESULT.

2-34. Refer to Figure 2-1 and locate the control to be adjusted.

2-35. Adjust the control until the transmitter deenergizes, then back the control off slightly, noting the direction of rotation.

2-36. Wait approximately three seconds and depress the OVERLOAD RESET and the HIGH VOLTAGE ON switch/indicators.

2-37. If the equipment does not return to operation, adjust the control a bit more in the direction of rotation noted in paragraph 2-35.

2-38. Wait approximately three seconds and depress the OVERLOAD RESET and the HIGH VOLTAGE ON switch/indicators.

2-39. If the transmitter does not return to operation, repeat paragraphs 2-37 and 2-38 until the control is adjusted to the point where the transmitter will just return to operation.

2-40. WARM-UP ADJUSTMENT (R101). This control adjusts the filament heating delay, prior to high voltage on. The control allows adjustment from 9 seconds to 2 minutes. A minimum interval is preset so that incorrect adjustment cannot damage the PA tube. To adjust the WARM-UP control on the controller circuit board, proceed as follows.

2-41. Required Equipment. The following equipment is required to adjust the WARM-UP control (R101).

A. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

B. Wristwatch with seconds hand or stopwatch function.

2-42. Procedure. To adjust the control, proceed as follows.

2-43. Apply filament power to the transmitter. Simultaneously note the time and depress the HIGH VOLTAGE ON switch/indicator.

2-44. Again note the time when the plate contactor energizes.

2-45. Refer to Figure 2-1 and adjust R101 to increase or decrease the time delay. Check the adjustment by repeating paragraphs 2-43 and 2-44. The control is factory set for 9 seconds.

2-46. COOL-DOWN ADJUSTMENT (R97). This control adjusts the blower run-down interval after high voltage is switched off. The control allows adjustment from 30 seconds to 2.5 minutes. A minimum interval is preset so that incorrect adjustment cannot damage the PA tube. To adjust the COOL-DOWN control on the controller circuit board, proceed as follows.

2-47. Required Equipment. The following equipment is required to adjust the COOL-DOWN control (R97).

A. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

B. Wristwatch with seconds hand or stopwatch function.

2-48. Procedure. To adjust the control, proceed as follows.

2-49. Apply power and operate the transmitter.

2-50. Simultaneously depress the FILAMENT OFF switch and note the time.

2-51. Again note the time when the blower halts operation.

2-52. Refer to Figure 2-1 and adjust R97 to increase or decrease the blower run-down interval. Check the adjustment by repeating paragraphs 2-50 and 2-51. The control is factory set for 45 seconds.

2-53. RECYCLE ADJUSTMENT (R67). This control adjusts the time the transmitter will remain deenergized to allow an overload to dissipate after an overload occurs. The control allows adjustment from 100 milliseconds to 2.5 seconds. A minimum delay is built into the circuitry to prevent transmitter damage. To adjust the RECYCLE control on the controller circuit board, proceed as follows.

2-54. Required Equipment. The following equipment is required to adjust the RECYCLE control (R67).

A. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

2-55. Procedure. To adjust the control, proceed as follows.

2-56. Apply power and operate the transmitter.

2-57. Refer to Figure 2-1 and adjust R67 for the desired delay. The control is factory preset for 2.5 seconds. The adjustment may be checked by simulating a screen or plate overload with the OUTPUT LOADING control.

2-58. WARM-UP DEFEAT ADJUSTMENT (R106). This control adjusts the length of the interval the transmitter will tolerate after a power interruption before initiating a new filament warm-up cycle. The control allows adjustment from 25 milliseconds to 5 seconds. A minimum delay is built into the circuitry so that momentary power fluctuations will not initiate a new filament warm-up cycle. To adjust the WARM-UP defeat control on the controller circuit board, proceed as follows.

2-59. Required Equipment. The following equipment is required to adjust the WARM-UP defeat control (R106).

A. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

B. Controller Extender Board (BE P/N 919-0061).

C. Wristwatch with seconds hand or stopwatch function.

2-60. <u>Procedure</u>. To adjust the control, proceed as follows.

2-61. Mount the controller circuit board on the extender board.

2-62. Apply power and operate the transmitter.

2-63. Refer to Figure 2-1 and adjust R106 for the desired interval. The control is factory preset for two seconds. The adjustment may be checked by interrupting the transmitter ac feed for known time intervals, and observing if the high voltage is reapplied immediately or a recycle is initiated.

2-64. Replace the controller circuit board in the transmitter.

2-65. PLATE I METER CAL. ADJUSTMENT (R125). This control adjusts the remote plate current meter output level for approximately 5 or 2.5 volts dc (depending on the remote logic programming) at normal plate current. To adjust the PLATE I meter cal. control on the controller circuit board, proceed as follows.

2-66. <u>Required Equipment</u>. The following equipment is required to adjust the PLATE I meter cal. control (R125).

A. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

B. Digital voltmeter, Fluke 8020 or equivalent 3 1/2 digit model.

2-67. <u>Procedure</u>. To adjust the control, proceed as follows.

<u>WARNING</u> DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-68. Assure all transmitter power is off and open the cabinet rear door. Connect the voltmeter between REMOTE INTERFACE PANEL TB3-25 and TB3-26 (meter ground).

2-69. Route the voltmeter leads out the hinge side of the cabinet door and close and lock the door.

2-70. Apply power and operate the transmitter at the normal power output.

2-71. Refer to Figure 2-1 and adjust R125 until the voltmeter indicates +5 or +2.5 volts dc (depending on the remote logic programming).

<u>WARNING</u> DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-72. Assure all transmitter power is off and disconnect the voltmeter and leads.

2-72. POWER SUPPLY CIRCUIT BOARD.

2-73. +15 VOLT ADJUST (R2). To adjust the +15 volt adjust control on the power supply circuit board, proceed as follows.

2-74. Required Equipment. The following equipment is required to adjust the +15 volt adjust control (R2).

A. Flat-blade screwdriver, 1/4 inch tip.

B. No. 2 Phillips screwdriver, 11 inch blade.

C. Insulated adjustment tool, flat-tip (BE P/N 407-0083).

D. Small pair of needle-nose pliers.

E. Power interlock line cord (BE P/N 682-0001), shipped with exciter accessory pack.

F. Fuse, 1 Ampere, Type AGC, quick acting.

G. Digital voltmeter, Fluke 75 or equivalent 3 1/2 digit model.

2-75. Procedure. To adjust the control, proceed as follows:

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-76. Assure all transmitter power is off.

2-77. Open the transmitter rear door and disconnect all plugs and cables from the rear of the transmitter controller chassis.

2-78. Remove the eight screws securing the transmitter controller in the rack.

2-79. Remove the transmitter controller from the rack and set the chassis on a work surface.

2-80. Remove the screws which secure the top on the transmitter controller and remove the top cover.

2-81. Remove the four screws securing the power supply in the chassis.

2-82. Disconnect the plug from the power supply circuit board.

2-83. Lift the power supply out of the chassis and set it on top of the card cage.

2-84. Connect the voltmeter between test point TP1 and chassis ground.

2-85. Remove the ac line voltage selector circuit board with a small pair of needle-nose pliers, reinsert the circuit board so that 115/120V is visible when the circuit board is reinserted into the receptacle.

2-86. Replace the fuse with a 1 Ampere fuse.

2-87. Apply power to the controller and adjust R2 to obtain a voltmeter indication of 15.6 volts dc.

WARNING DISCONNECT PRIMARY POWER BEFORE PROCEEDING.

2-88. Assure primary power is disconnected before proceeding.

2-89. Disconnect the voltmeter.

2-90. Remove the ac line voltage selector circuit board with a small pair of needle-nose pliers. Reinsert the circuit board so that 220V is visible when the circuit board is reinserted into the receptacle.

2-91. Replace the fuse with the original 1/2 Ampere slow-blow fuse.

2-92. Secure the power supply in the controller chassis and reconnect the circuit board plug.

2-93. Replace the top cover on the controller.

WARNING DISCONNECT ALL TRANSMITTER PRIMARY POWER BEFORE PROCEEDING.

2-94. Replace the controller in the transmitter. Connect the rear panel plugs.

2-95. TROUBLESHOOTING.

WARNING WARNING WARNING	NEVER OPEN THE EQUIPMENT UNLESS ALL TRANSMITTER PRIMARY POWER IS DISCONNECTED. USE THE GROUNDING STICK PROVIDED TO ENSURE ALL COMPONENTS AND ALL SURROUNDING COMPONENTS ARE DISCHARGED BEFORE ATTEMPTING ANY MAINTENANCE ON ANY AREA WITHIN THE TRANSMITTER.

2-96. Most troubleshooting consists of visual checks. Because of the high voltages and currents in the equipment, it is considered hazardous to work with power energized. Therefore, the various transmitter indicators (meters, LEDs, and fuses) should be used to isolate the malfunction to one specific area.

2-97. Troubleshooting within the controller card cage is not considered hazardous due to the low potentials and currents involved. An extender circuit board (BE P/N 919-0061) is provided to assist troubleshooting. When the extender circuit board is not used, it must be inserted in the far left side position in the controller card cage to allow the front door to close.

2-98. Once the trouble is isolated and power is totally deenergized, it is suggested that the exact problem be located with resistance checks using the schematic diagrams and theory of operation presented throughout the text.

CAUTION CAUTION	MANY COMPONENTS IN THE TRANSMITTER ARE MOUNTED TO HEAT-SINKS UTILIZING A THIN FILM OF HEAT-SINK COMPOUND FOR THERMAL CONDUCTION.
CAUTION CAUTION	IF ANY SUCH COMPONENT IS REPLACED, ENSURE A THIN FILM OF A ZINC-BASED HEAT-SINK COMPOUND IS USED (BE P/N 700-0028) TO ASSURE GOOD HEAT DISSIPATION.

2-99. If a circuit is diagnosed as faulty, the circuit fault may be isolated and repaired locally or the entire device may be returned to Broadcast Electronics, Inc. for exchange, alignment, or replacement.

2-100. A built-in microprocessor video diagnostic system is optionally available which enables the transmitter controller to display fault conditions and diagnosis to the sub-system level in plain English on a CRT screen. The system may be field-installed in an existing transmitter.

SECTION III

DRAWINGS

3-1. INTRODUCTION.

3-2. This section provides assembly drawings, schematic diagrams, and wiring diagrams as indexed below for the FM-10A transmitter controller.

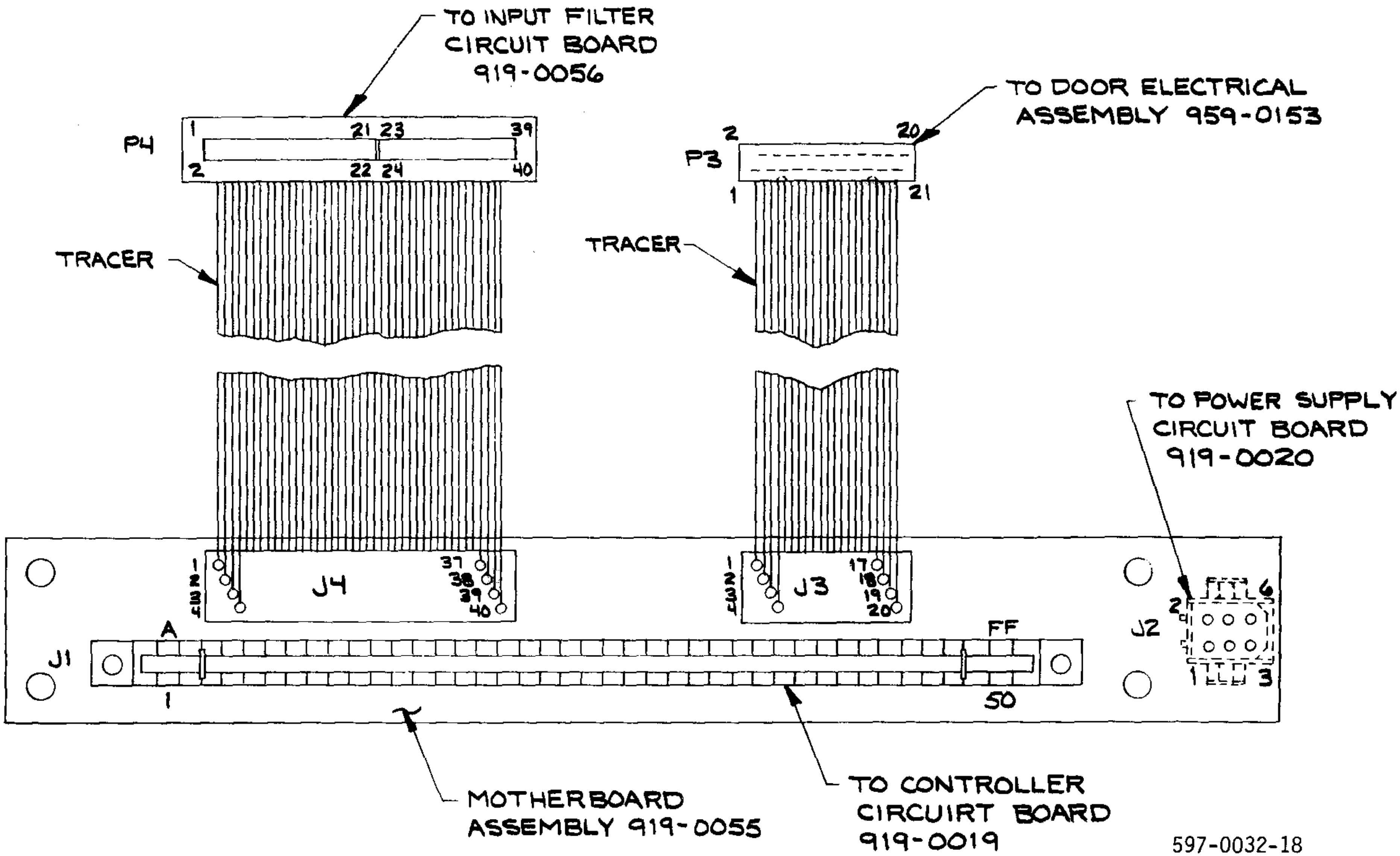
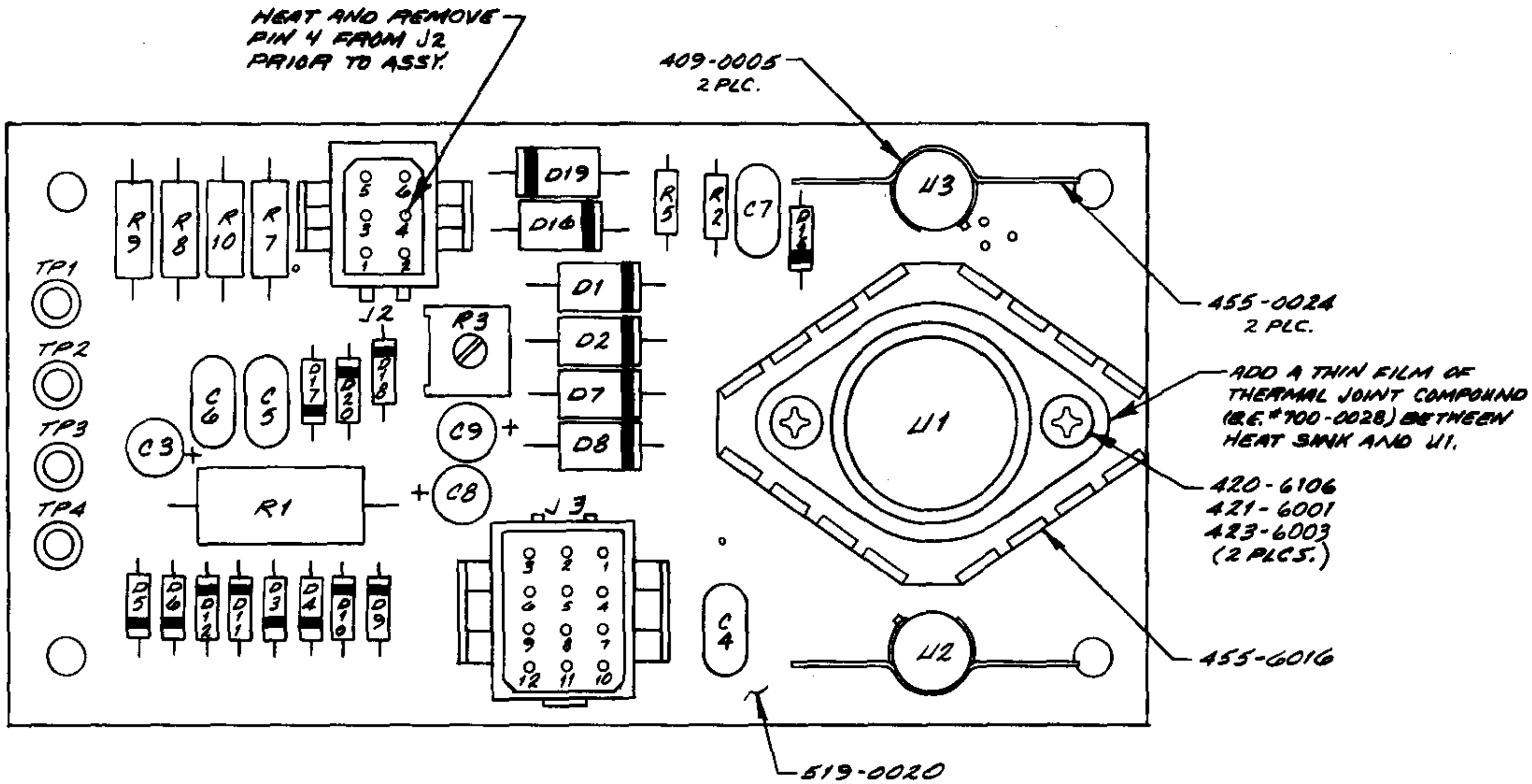


FIGURE 3-4. MOTHERBOARD ASSEMBLY



SEE SCHEMATIC #C959-0045
SEE B/M # 919-0020

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL±.01 3PL±.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL

DRAWN BY MERKEL	DATE 1-11-83		
CHECKED BY	DATE		
PROJECT ENGR	DATE 5-16-83		
APPROVED BY MH	5-16-83		

TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.

TITLE PCB ASSEMBLY TRANSMITTER CONTROLLER POWER SUPPLY

B DWG. NO. 919-0020 REV. B

XMTRS SCALE 2/1 SHEET 1 OF 1

REF	ZONE	REF	ZONE	REF	ZONE	REF	ZONE	REF	ZONE	REF	ZONE	REF	ZONE	REF	ZONE
C1	C2	C44	C3	P5	C3	R39	---	R82	B5	R125	A2	R168	A3	U31	B3-B2
C2	B1	C45	B4-C4	P6	A5	R40	---	R83	C4	R126	A3	S1	C5	U32	C1
C3	B2	D1	C5	P8	C4	R41	---	R84	C4	R127	A2	S2	C3	U33	B1
C4	A1	D2	C5	Q1	A5	R42	---	R85	B5	R128	A2	TP1	C3	U34	B2-B1
C5	B2	D3	A5	Q2	C5	R43	---	R86	B5	R129	A1	TP2	C4	U35	B1
C6	A1	D4	A5	R1	A3	R44	A5	R87	C5	R130	A2-A1	TP3	C4	U36	B2-B1
C7	B1	D5	C5	R2	B1	R45	---	R88	C5	R131	A1	TP4	C3	U37	A2
C8	B4	D6	C5	R3	A1	R46	B5	R89	B5	R132	A1	TP5	C3	U38	A2
C9	B3	D7	C5	R4	A2	R47	A5	R90	B5	R133	A2	TP6	C4	U39	A2
C10	B2	D8	A5	R5	A1	R48	A5	R91	B5	R134	A2	TP7	C2	U40	A3
C11	A5	D9	A5	R6	A1	R49	B5-C5	R92	B5	R135	A2	TP8	C3	U41	A2
C12	A5	D10	B5	R7	B1	R50	B5	R93	B5	R136	A2	TP9	C3	U42	A2
C13	A5	D11	C5	R8	B1	R51	C5	R94	B5	R137	A3	TP10	A5	U43	A1
C14	B5	D12	A5	R9	A1	R52	B5	R95	B5	R138	A2	U1	A1	U44	A2-A1
C15	C5	D13	C4-C3	R10	B1	R53	B5	R96	C3	R139	A2	U2	A1	U45	A1
C16	B5	D14	A1	R11	A1	R54	B5	R97	C4-C5	R140	A1	U3	A1	U46	A1
C17	A5	D15	A1	R12	A1	R55	C4	R98	C3	R141	A1	U4	A1	U47	A2
C18	B4	D16	A1	R13	B2	R56	C5	R99	A4	R142	A1	U5	A1	U48	A2-A1
C19	C4	D17	A1	R14	B1	R57	A5	R100	A4	R143	A1	U6	A1	U49	A2
C20	B4	D18	A1	R15	A1	R58	B5	R101	C3	R144	A2	U7	A3-A2	U50	A2
C21	C4	D19	A2	R16	A1	R59	C5	R102	C3	R145	A2	U8	A3	U51	C3-C2
C22	A5	D20	A2	R17	A3	R60	C5	R103	C3	R146	A2	U9	B2	U52	C2
C23	B5	D21	A5	R18	B4	R61	A5	R104	C4	R147	A2	U10	B1	U53	C2-C1
C24	A5	D22	A3	R19	C2	R62	B5	R105	C4	R148	C5	U11	B3	U54	C1
C25	B5	D23	B3	R20	A3	R63	A4	R106	C4	R149	C3	U12	B4	U55	C2-C1
C26	B5	D24	A2	R21	---	R64	B4	R107	B4	R150	B3	U13	B4	U56	C2
C27	A5	D25	A5	R22	C3	R65	B4	R108	A4	R151	A3	U14	B3-B2	U57	B4
C28	B5	D26	C5	R23	---	R66	C4	R109	C1	R152	C4	U15	B5	U58	A3
C29	C4	D27	B5	R24	A5	R67	C4	R110	C1	R153	A2	U16	B5	U59	A3
C30	A5-A4	D28	A5	R25	A5	R68	C5-C4	R111	C1	R154	B2	U17	B2		
C31	A4	D29	C4	R26	A5	R69	C4	R112	C1	R155	B2	U18	A4		
C32	C3	D30	A5	R27	C5	R70	C4	R113	B1	R156	B1	U19	A4		
C33	C4	D31	C5	R28	C5	R71	B4	R114	B1	R157	A1	U20	B5		
C34	B4	D32	B5	R29	C5-C4	R72	B5	R115	B1	R158	B3	U21	B5		
C35	C1	F1	A5	R30	C5	R73	B5	R116	B1	R159	C2	U22	B5		
C36	C2	J3	A5	R31	C5	R74	C4	R117	C1	R160	A2	U23	B3		
C37	C4	J4	C3	R32	C3	R75	C4	R118	B1	R161	---	U24	B3		
C38	C2	J5	C3	R33	A4	R76	A5	R119	B2	R162	A3	U25	B4		
C39	B3	J6	A5	R34	A4	R77	B5	R120	B2	R163	C3	U26	B4		
C40	B3-C3	J7	A3-A4	R35	---	R78	C5	R121	B3	R164	C3	U27	A4		
C41	B3-C3	J8	C4	R36	C4	R79	A5	R122	A2	R165	A3	U28	C4		
C42	A3	P3	A5	R37	---	R80	C5-C4	R123	A2	R166	A4	U29	C4		
C43	A3	P4	C3	R38	---	R81	C5	R124	A2	R167	C3	U30	B3		

597-0032-19

FIGURE 3-11. CONTROLLER CIRCUIT BOARD COMPONENT LOCATOR

SECTION IV

PARTS LIST

4-1. INTRODUCTION.

4-2. This section provides descriptions and part numbers of electrical components, assemblies, and selected mechanical parts required for maintenance of the Broadcast Electronics FM-10A Transmitter Controller. Each table entry in this section is indexed by reference designators appearing on the applicable schematic diagram.

TABLE 4-1. TRANSMITTER CONTROLLER PARTS LIST INDEX

TABLE 4-2. TRANSMITTER CONTROLLER - 959-0046

REF. DES.	DESCRIPTION	PART NO.	QTY.
B1	Fan Assembly; consisting of: 1. Fan, 115V, 50/60 Hz, 70 ft^3/min, 4.71 In. X 4.71 In. X 1.5 In. 2. 6-Pin Receptacle (J2) and Wiring	380-6300	1
BT1	Battery, 9 Volt, Alkaline	350-0002	1
	220V AC Input Operation		
F1, SPARE	Fuse, AGC, 250V, 1/2 Ampere, Slow-Blow	334-0050	2
	110V AC Input Operation		
F1, SPARE	Fuse, AGC, 250V, 1 Ampere, Slow-Blow	334-0100	2
----	Receptacle, Turn-Lock, for optional video monitor	420-0022	2
----	Door Electrical Assembly	959-0153	1
----	Extender Circuit Board Assembly	919-0061	1
----	Controller Circuit Board	919-0019	1
----	Power Supply Assembly	959-0045	1
----	Motherboard Assembly	959-0155	1
----	Input Filter Circuit Board	919-0056	1
----	EMI/AC Power Cable Assembly	949-0026	1

TABLE 4-3. MOTHERBOARD ASSEMBLY - 959-0155

REF. DES.	DESCRIPTION	PART NO.	QTY.
P2,P2	Plug, 6-Pin	418-0670	2
P3	Plug, 20-Pin	417-0207	1
P4	Plug, 40-Pin	417-0038	1
----	Pins for P2,P2	417-0053	10
----	Motherboard Circuit Board	919-0055	1

TABLE 4-4. MOTHERBOARD CIRCUIT BOARD - 919-0055

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	Receptacle, 100-Pin	418-5001	1
J2	Receptacle, 6-Pin	417-0677	1
J3	Receptacle, 20-Pin	418-0027	1
J4	Receptacle, 40-Pin	418-0028	1
----	Blank Circuit Board	519-0055	1

TABLE 4-5. DOOR ELECTRICAL ASSEMBLY - 959-0153

REF. DES.	DESCRIPTION	PART NO.	QTY.
DS1 THRU DS4	Indicator, LED, Red, 521-9212, 2V @ 50 mA Maximum (OVERLOAD Indicators)	323-9217	4
DS5 THRU DS8	Indicator, LED, Green, 521-9176, 3V @ 40 mA Maximum (STATUS Indicators)	323-9224	4
DS9 THRU DS12	Lamp, Incandescent, No. 73, 14V @ 0.08 Ampere, T 1 3/4 Base	320-0007	4
J1,J1	Receptacle, 16-Pin, DIP	417-1604	2
J3	Receptacle, 20-Pin	417-0201	1
S1 THRU S4	Switch, Push, SPST, Illuminated, 3 Ampere @ 125V (FILAMENT ON, FILAMENT OFF, HIGH VOLTAGE ON, HIGH VOLTAGE OFF)	340-0018	4
S5	Switch, Push, SPST, 3 Ampere @ 125V (OVERLOAD Reset)	340-0015-001	1
XBT1	Battery Holder, 9 Volt Rectangular	415-0002	1
----	Bezel for DS1 thru DS8	454-0004	8
----	Lens, Red (for S2 and S4)	346-1018	2
----	Lens, Green (for S1 and S3)	340-0016	2
----	Lens, Yellow (for S5)	340-0014	1
----	Front Door Switchboard to LED Board Cable	949-0028	1
----	Blank LED Circuit Board	519-0025	1
----	Blank Switch Circuit Board	519-0026	1

TABLE 4-6. FRONT DOOR SWITCHBOARD TO LED BOARD CABLE - 949-0028

REF. DES.	DESCRIPTION	PART NO.	QTY.
P1,P1	Plug, 16-Pin DIP	417-1602	2

TABLE 4-7. INPUT FILTER CIRCUIT BOARD - 919-0056

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1 THRU C136	Capacitor, Mica, 390 pF ±5%, 100V	042-3922	136
J1 THRU J3	Receptacle, 25-Pin	417-2500	3
J7	Receptacle, Header, 3-Pin In-line	417-0003	1
L1 THRU L50	Coil, Molded, 4.7 uH ±10%, 430 mA Maximum, DC Resistance: 0.55 Ohms, Resonant at 130 MHz	360-0022	50
P7	Jumper, Programmable	340-0004	1
R9 THRU R13, R17,R19,R20, R25 THRU R34	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	18
R35	Resistor Network, 8-10 k Ohm ±1%, 1/4W resistors, 16-Pin DIP	226-1055	1
U1,U2	Integrated Circuit, MC1416P, 7 NPN Darlington Drivers, 16-Pin DIP	226-2004	2
XU1,XU2, XR35	Socket, 16-Pin DIP	417-1604	3
----	Header, Programmable (for U1, J2, and R35)	340-0006	5

TABLE 4-8. CONTROLLER CIRCUIT BOARD - 919-0019
(Sheet 1 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C2 THRU C4	Capacitor, Electrolytic, 4.7 uF, 35V	024-4764	3
C5	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C6,C7	Capacitor, Electrolytic, 4.7 uF, 35V	024-4764	2
C8	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C9	Capacitor, Mylar Film, 0.01 uF, 100V	030-1043	1
C10	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C11	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C12	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C13	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
C14	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C15	Capacitor, Electrolytic, 100 uF, 25V	023-1084	1
C16	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C17	Capacitor, Mylar Film, 0.01 uF, 100V	030-1043	1
C18,C19	Capacitor, Electrolytic, 4.7 uF, 35V, Tantalum	064-4763	2
C20	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C21	Capacitor, Electrolytic, 100 uF ±10%, 25V, Low-Leakage	023-1085	1
C22	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C23,C24	Capacitor, Electrolytic, 1 uF, 50V	024-1064	2
C25	Capacitor, Ceramic, 0.1 uF ±20%, 50V	024-1054	1
C26	Capacitor, Electrolytic, 1 uF, 50V	020-1064	1
C27	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C28	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	1
C29	Capacitor, Electrolytic, 100 uF ±10%, 25V, Low-Leakage	023-1085	1
C30,C31	Capacitor, Mylar Film, 0.01 uF, 100V	030-1043	2
C32	Capacitor, Electrolytic, 100 uF ±10%, 25V, Low-Leakage	023-1085	1
C33	Capacitor, Electrolytic, 4.7 uF, 35V, Tantalum	064-4763	1
C34	Capacitor, Electrolytic, 1 uF, 50V	024-1064	1
C35 THRU C39	Capacitor, Ceramic, 0.1 uF ±20%, 50V	003-1054	5
C40,C41	Capacitor, Mylar Film, 0.22 uF, 100V	030-2253	2
C42	Capacitor, Mylar Film, 0.01 uF, 100V	030-1043	1
C43	Capacitor, Mylar Film, 0.1 uF, 100V	030-1053	1
C44	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
C45	Capacitor, Electrolytic, 100 uF ±10%, 25V	023-1085	1
D1 THRU D4	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	4

TABLE 4-8. CONTROLLER CIRCUIT BOARD - 919-0019
(Sheet 2 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
D5	POWER Indicator, LED, Green, 550-2206, 2.3V @ 50 mA Maximum	323-2206	1
D6	Diode, Zener, 1N4742A, 12V ±5%, 1W	200-4742	1
D7 THRU D9	Diode, Zener, 1N4744A, 15V ±5%, 1W	200-0015	3
D10	Diode, HP5082-2800, High Voltage Schottky Barrier, 70V @ 15 mA Maximum	201-2800	1
D11	TEST Indicator, LED, Green, 550-2206, 2.3V @ 50 mA Maximum	323-2206	1
D12	Diode, 1N6276A, Transient Voltage Suppressor, 15.2 Volt, 67 Ampere Peak Current	206-6276	1
D13 THRU D22	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	10
D23,D24	Diode, 1N4008, Silicon, 75V @ 0.3 Amperes	203-4148	2
D25 THRU D30	Diode, Zener, 1N4739A, 9.1V ±5%, 1W	200-0009	6
D31	Diode, 1N4005, Silicon, 600V, 1 Ampere	203-4005	1
D32	Diode, Zener, 1N4739A, 9.1V ±5%, 1W	200-0009	1
F1	Fuse, AGC, 250V, 1 Ampere	330-0100	1
J3 THRU J5	Receptacle, Header, 2-Pin	417-4004	3
J6	Receptacle, Header, 3-Pin	417-0003	1
J7,J8	Receptacle, Header, 2-Pin	417-4004	2
P3 THRU P8	Plug, 2-Pin	340-0004	6
Q1	Transistor, 2N3904, Silicon, NPN, TO-92 Case	211-3904	1
Q2	Transistor, MPSA14, Silicon, NPN Darlington, TO-92 Case	211-0014	1
R1,R2	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R3	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R4,R5	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R6	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R7,R8	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R9	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R10,R11	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R12	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R13,R14	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R15	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R16,R17	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R18	Resistor, 51 k Ohm ±5%, 1/4W	100-5153	1
R19,R20,R22	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	3
R24	Resistor, 390 k Ohm ±5%, 1/4W	100-3963	1
R25	Resistor, 4.7 k Ohm ±5%, 1/4W	100-4743	1
R26	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R27	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R28	Resistor, 470 Ohm ±5%, 1/2W	110-4733	1
R29	Resistor, 9.1 k Ohm ±5%, 1/4W	100-9143	1
R30	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R31	Resistor, 5.6 Ohm ±5%, 1/4W	100-5643	1
R32	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R33	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R34	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R36	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R44,R46,R47	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	3
R48	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R49	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R50	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R51	Resistor, 100 Ohm ±5%, 1/4W	100-1033	1
R52	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R53	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R54	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R55	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R56	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R57	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R58	Resistor, 1.2 Meg Ohm ±5%, 1/4W	100-1273	1
R59,R60	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R61,R62	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	2
R63	Resistor, 51 k Ohm ±5%, 1/4W	100-5153	1
R64	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R65	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R66	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R67	Potentiometer, 500 k Ohm ±10%, 1/2W	178-5064	1
R68	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R69	Resistor, 560 k Ohm ±5%, 1/4W	100-5663	1

TABLE 4-8. CONTROLLER CIRCUIT BOARD - 919-0019
(Sheet 3 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
R70	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R71	Resistor, 51 k Ohm ±5%, 1/4W	100-5153	1
R72	Resistor, 560 k Ohm ±5%, 1/4W	100-5663	1
R73	Resistor, 47 k Ohm ±5%, 1/4W	100-4753	1
R74	Resistor, 68 k Ohm ±5%, 1/4W	100-6853	1
R75	Potentiometer, 5 k Ohm ±10%, 1/2W	178-5044	1
R76	Resistor, 24 k Ohm ±5%, 1/4W	100-2453	1
R77	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R78	Resistor, 22 k Ohm ±5%, 1/4W	100-2253	1
R79	Resistor, 150 k Ohm ±5%, 1/4W	100-1563	1
R80	Potentiometer, 5 k Ohm ±10%, 1/2W	178-5044	1
R81	Resistor, 24 k Ohm ±5%, 1/4W	100-2453	1
R82	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R83	Resistor, 68 k Ohm ±5%, 1/4W	100-6853	1
R84	Potentiometer, 5 k Ohm ±10%, 1/2W	178-5044	1
R85	Resistor, 5.1 k Ohm ±5%, 1/4W	100-5143	1
R86	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R87	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R88	Potentiometer, 5 k Ohm ±10%, 1/2W	178-5044	1
R89	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R90	Resistor, 47 k Ohm ±5% 1/4W	100-4753	1
R91	Resistor, 10 Meg Ohm ±5%, 1/4W	100-1083	1
R92	Resistor, 1 Meg Ohm ±5%, 1/4W	100-1073	1
R93	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R94	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R95	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R96	Resistor, 330 k Ohm ±5%, 1/4W	100-3363	1
R97	Potentiometer, 1 Meg Ohm ±10%, 1/2W	178-1074	1
R98	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R99,R100	Resistor, 51 k Ohm, ±5%, 1/4W	100-5153	2
R101	Potentiometer, 1 Meg Ohm ±10%, 1/2W	178-1074	1
R102	Resistor, 110 k Ohm ±5%, 1/4W	100-1163	1
R103,R104	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	2
R105	Resistor, 4.3 k Ohm ±5%, 1/4W	100-4343	1
R106	Potentiometer, 1 Meg Ohm ±10%, 1/2W	177-1074	1
R107	Resistor, 51 k Ohm ±5%, 1/4W	100-5153	1
R108	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R109 THRU R121	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	13
R122 THRU R124	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	3
R125	Resistor, 10 k Ohm ±5%, 1/4W	100-1053	1
R126	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R127 THRU R136	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	10
R137 THRU R139	Resistor, 20 Ohm ±5%, 1/4W	100-2023	3
R140 THRU R148	Resistor, 620 Ohm ±5%, 1/2W	110-6233	8
R149	Resistor, 470 k Ohm ±5%, 1/4W	100-4763	1
R150	Resistor, 1.3 Meg Ohm ±5%, 1/4W	100-1373	1
R151	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R152	Potentiometer, 250 k Ohm ±10%, 1/2W	180-0001	1
R153	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R154 THRU R159	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	6
R160	Resistor, 51 k Ohm ±5%, 1/4W	100-5153	1
R162	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R163	Resistor, 1.5 Meg Ohm ±5%, 1/4W	100-1573	1
R164	Resistor, 1.8 Meg Ohm ±5%, 1/4W	100-1873	1
R165	Resistor, 1 k Ohm ±5%, 1/4W	100-1043	1
R166	Resistor, 100 k Ohm ±5%, 1/4W	100-1063	1
R167	Resistor, 470 k Ohm ±5%, 1/4W	100-4763	1
R168	Resistor, 10 Ohm ±5%, 1/4W	100-1023	1
S1	Switch, Push, SPST, Normally Open, 1 Ampere @ 120V ac	343-6330	1
S2	Switch, Toggle, SPST, 5 Ampere @ 120V ac or 28V ac	348-0123	1
U1 THRU U8	Integrated Circuit, 4N33, Optical Isolator, NPN Photo Transistor/Infared Emitting Diode Type, 1500V Isolation, 6-Pin DIP	229-0033	8

TABLE 4-8. CONTROLLER CIRCUIT BOARD - 919-0019
(Sheet 4 of 4)

REF. DES.	DESCRIPTION	PART NO.	QTY.
U9 THRU U11	Integrated Circuit, MC14002B, Dual 4-Input NOR Gate, CMOS, 14-Pin DIP	228-4002	3
U12	Integrated Circuit, MC14069UB, Hex Inverter, CMOS, 14-Pin DIP	228-4069	1
U13	Integrated Circuit, CD4071B, OR Gate, CMOS, 14-Pin DIP	225-0005	1
U14	Integrated Circuit, CD4081B, AND Gate, CMOS, 14-Pin DIP	225-0008	1
U15,U16	Integrated Circuit, LM358N, Dual Operational Amplifier, 8-Pin DIP	221-0358	2
U17	Integrated Circuit, MC14044BP, Quad NAND R-S Latch, CMOS, 16-Pin DIP	228-4044	1
U18	Integrated Circuit, MC14069UB, Hex Inverter, CMOS, 14-Pin DIP	228-4069	1
U19	Integrated Circuit, CD4081B, AND Gate, CMOS, 14-Pin DIP	225-0008	1
U20 THRU U22	Integrated Circuit, LM358N, Dual Operational Amplifier, 8-Pin DIP	221-0358	3
U23	Integrated Circuit, MC14538B, Dual Resettable/Retriggerable Monostable Multivibrator, CMOS, 16-Pin DIP	228-4538	1
U24	Integrated Circuit, CD4071B, OR Gate, CMOS, 14-Pin DIP	225-0005	1
U25	Integrated Circuit, MC14073B, Tripple 3-Input AND Gate, CMOS, 14-Pin DIP	228-4073	1
U26	Integrated Circuit, CD4081B, AND Gate, CMOS, 14-Pin DIP	225-0008	1
U27	Integrated Circuit, MC14069UB, Hex Inverter, CMOS, 14-Pin DIP	228-4069	1
U28,U29	Integrated Circuit, MC14538B, Dual Resettable/Retriggerable Monostable Multivibrator, CMOS, 16-Pin DIP	228-4538	1
U30	Integrated Circuit, MC14011B, Quad 2-Input NAND Gate, CMOS, 14-Pin DIP	228-4011	1
U31	Integrated Circuit, MC14044BP, Quad NAND R-S Latch, CMOS, 16-Pin DIP	228-4044	1
U32 THRU U34	Integrated Circuit, CD4019BE, Quad AND/OR Select Gate, CMOS, 16-Pin DIP	228-4019	3
U35,U36	Integrated Circuit, ULN2003A, 7 Section NPN Darlington Driver, CMOS, 16-Pin DIP	229-2003	2
U37 THRU U50	Integrated Circuit, 4N33, Optical Isolator, NPN Photo Transistor/Infared Emitting Diode Type, 1500V Isolation, 6-Pin DIP	229-0033	14
U51	Integrated Circuit, MC14584, Hex Schmitt Trigger, CMOS, 14-Pin DIP	228-4584	1
U52 THRU U56	Integrated Circuit, MC14503B, Hex Non-Inverting 3-State Buffer, CMOS, 16-Pin DIP	228-4503	5
U57	Integrated Circuit, CD4017B, 10-Output Counter/Divider, CMOS, 16-Pin DIP	220-4017	1
U58,U59	Integrated Circuit, 4N33, Optical Isolator, NPN Photo Transistor/Infared Emitting Diode Type, 1500V Isolation, 6-Pin DIP	229-0033	2
XF1	Fuse Clip, AGC	415-2068	2
XU1 THRU XU8	Socket, 6-Pin DIP	417-0600	8
XU9 THRU XU14	Socket, 14-Pin DIP	417-1404	6
XU15,XU16	Socket, 8-Pin DIP	417-0804	2
XU17	Socket, 16-Pin DIP	417-1604	1
XU18,XU19	Socket, 14-Pin DIP	417-1404	2
XU20 THRU XU22	Socket, 8-Pin DIP	417-0804	3
XU23	Socket, 16-Pin DIP	417-1604	1
XU24 THRU XU27	Socket, 14-Pin DIP	417-1404	4
XU28,XU29	Socket, 16-Pin DIP	417-1604	2
XU30	Socket, 14-Pin DIP	417-1404	1
XU31 THRU XU36	Socket, 16-Pin DIP	417-1604	6
XU37 THRU XU50	Socket, 6-Pin DIP	417-0600	14
XU51	Socket, 14-Pin DIP	417-1404	1
XU52 THRU XU57	Socket, 16-Pin DIP	417-1604	6
XU58	Socket, 6-Pin DIP	417-0600	1
----	Blank Circuit Board	519-0019	1

TABLE 4-9. EXTENDER CIRCUIT BOARD - 919-0061

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	Receptacle, 100-Pin	418-5001	1
S1	Push Switch, SPST, Normally Open, 1 Ampere @ 120V ac	343-6330	1
----	Switch Cap, for J1	343-6331	1
----	Blank Circuit Board	519-0061	1

TABLE 4-10. POWER SUPPLY ASSEMBLY - 959-0045

REF. DES.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor, Electrolytic, 15,000 uF, 50V	024-1590	1
C2	Capacitor, Electrolytic, 2500 uF, 50V	024-2590	1
----	Power Transformer and Wire Harness	959-0157	1
----	Power Supply Circuit Board	919-0020	1

TABLE 4-11. POWER TRANSFORMER AND WIRE HARNESS - 959-0157

REF. DES.	DESCRIPTION	PART NO.	QTY.
J1	Receptacle, 6-Pin	418-0006	1
P3	Plug, 12-Pin	418-1271	1
T1	Power Transformer, Single Phase, 50/60 Hz Primary: Dual 115 Volt Windings, One Winding tapped at 90V Secondary: 17.6V RMS @ 0.1 Ampere Open Circuit 20.4V RMS @ 0.4 Ampere Open Circuit 20.4V RMS @ 2 Amperes Open Circuit	370-0005	1
----	Pins for J1	417-0036	5
----	Pins for P3	417-0053	10

TABLE 4-12. POWER SUPPLY CIRCUIT BOARD - 919-0020

REF. DES.	DESCRIPTION	PART NO.	QTY.
C3	Capacitor, Electrolytic, 10 uF, 35V	023-1076	1
C4 THRU C7	Capacitor, Mylar Film, 0.1 uF ±10%, 100V	030-1053	4
C8,C9	Capacitor, Electrolytic, 10 uF, 35V	023-1076	2
D1,D2	Diode, MR502, Silicon, 200V, 3 Amperes	202-0502	2
D3 THRU D6	Diode, 1N4004, Silicon, 400V, 1 Ampere	203-4004	4
D7,D8	Diode, MR502, Silicon, 200V, 3 Amperes	202-0502	2
D9 THRU D12,D15	Diode, 1N4004, Silicon, 400V, 1 Ampere	203-4004	5
D16	Diode, MR502, Silicon, 200V, 3 Amperes	202-0502	1
D17,D18	Diode, 1N4004, Silicon, 400V, 1 Ampere	203-4004	2
D19	Diode, MR502, Silicon, 200V, 3 Amperes	202-0502	1
D20	Diode, 1N4004, Silicon, 400V, 1 Ampere	203-4004	1
J2	Receptacle, 6-Pin	417-0677	1
J3	Receptacle, 12-Pin	417-1276	1
R1	Resistor, 470 Ohm ±5%, 2W	130-4733	1
R2	Resistor, 1.27 k Ohm ±1%, 1/4W	103-1274	1
R3	Potentiometer, 200 Ohm ±10%, 1/2W	177-2034	1
R5	Resistor, 120 Ohm ±5%, 1/4W	100-1233	1
R7 THRU R10	Resistor, 1 k Ohm ±5%, 1/2W	110-1043	4
U1	Integrated Circuit, LM350K, Three-Terminal Adjustable Positive Voltage Regulator, 1.2V to 33V, 3 Ampere Maximum, TO-3 Case	227-0350	1
U2,U3	Integrated Circuit, LM78L15ACH, Three-Terminal Fixed 15 Volt Regulator, 0.1 Ampere, 15V, TO-39 Case	227-7800	2
----	Blank Circuit Board	519-0020	1

TABLE 4-13. EMI/AC POWER CABLE ASSEMBLY - 949-0026

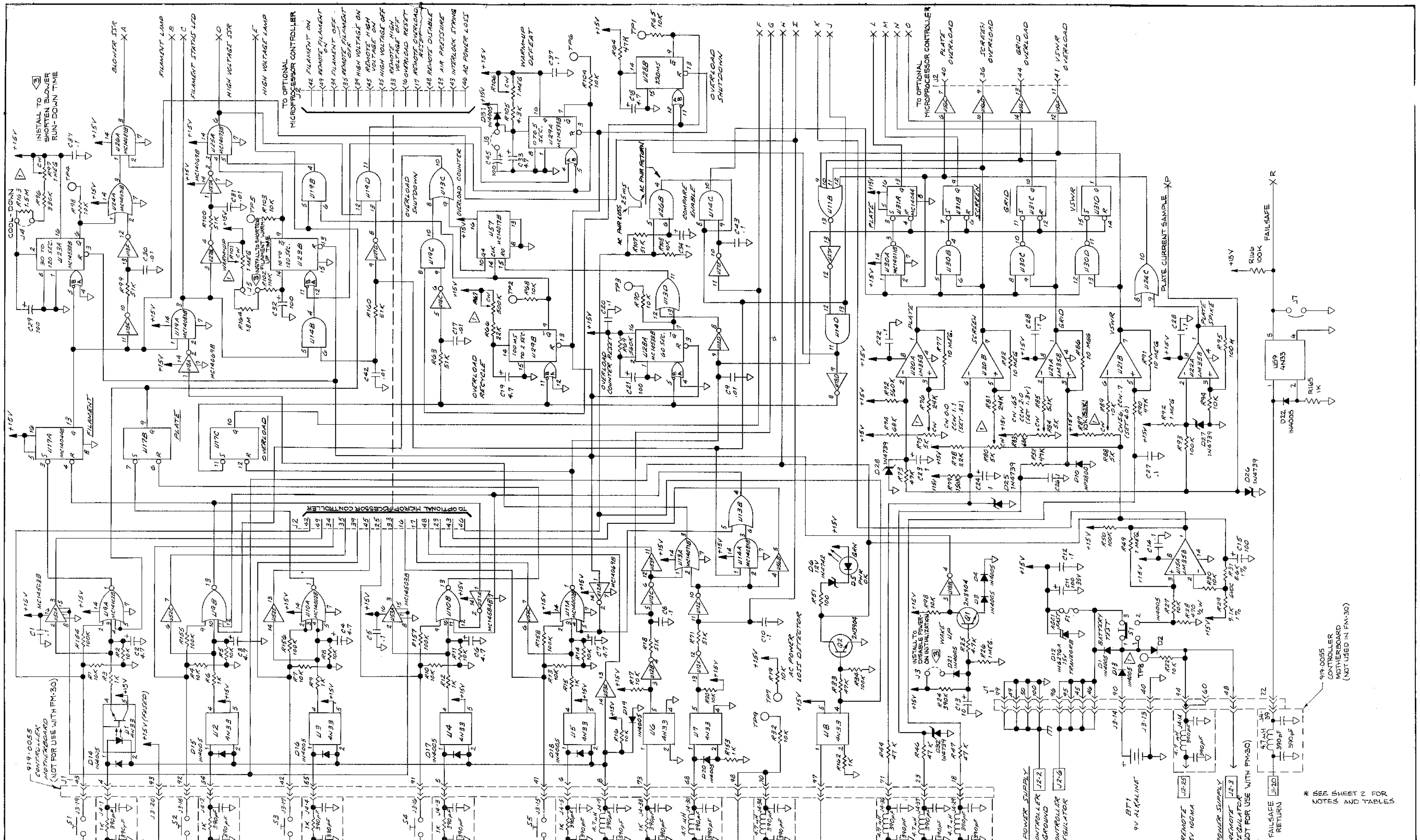
REF. DES.	DESCRIPTION	PART NO.	QTY.
FL1	Fused Power Connector/120/240V Voltage Selector/EMI Filter	360-6504	1
MOV1	Metal-Oxide Varistor, V250LA15A, 250V RMS, 15 Joules	140-0008	1
P1,P2	Plug, 6-Pin	418-0670	2
----	Pins for P1 and P2	417-0053	10

INSTRUCTION MANUAL

FM-10A
10 KILOWATT
FM TRANSMITTER

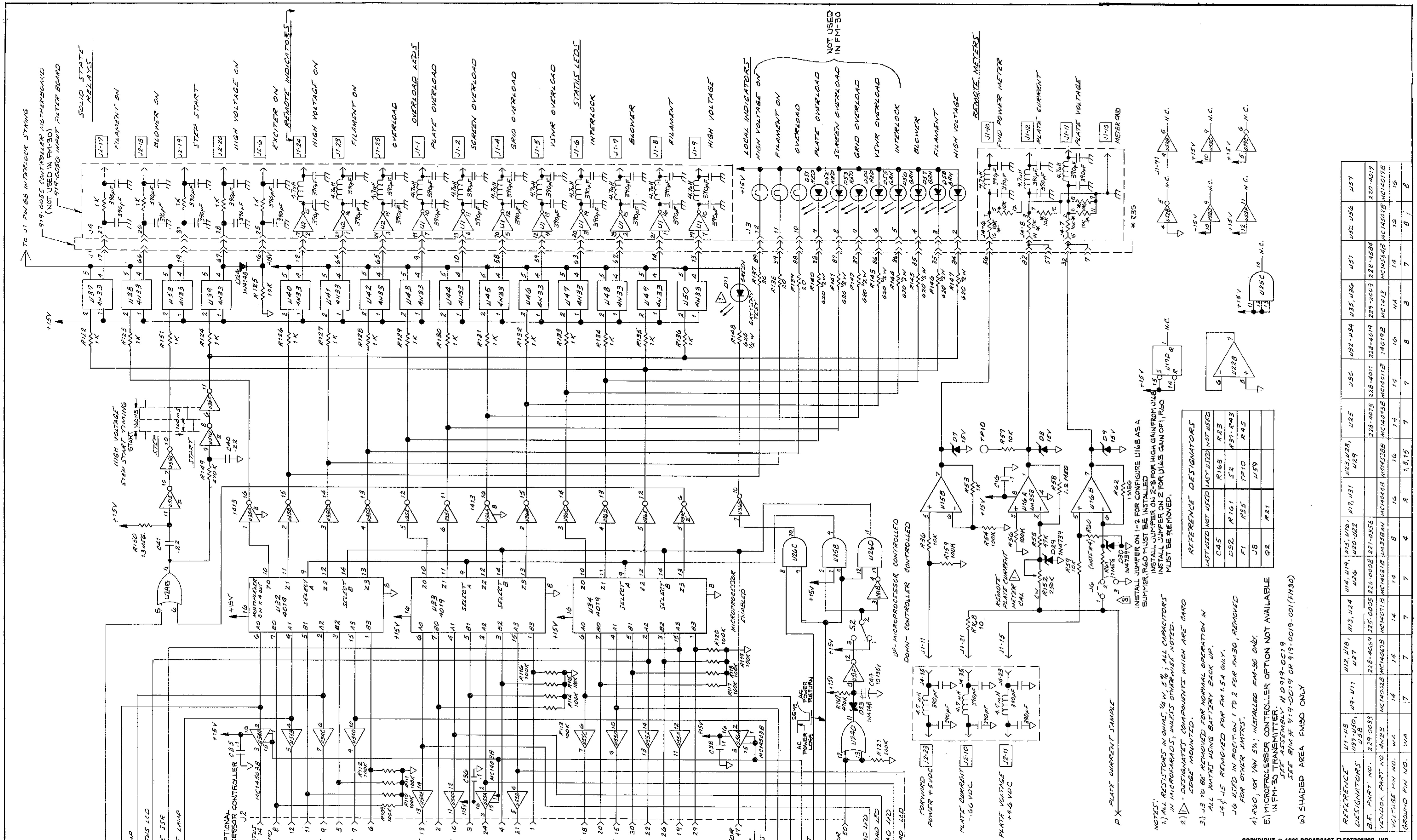
April, 1988 **IM No. 597-0098**

BROADCAST ELECTRONICS, INC.



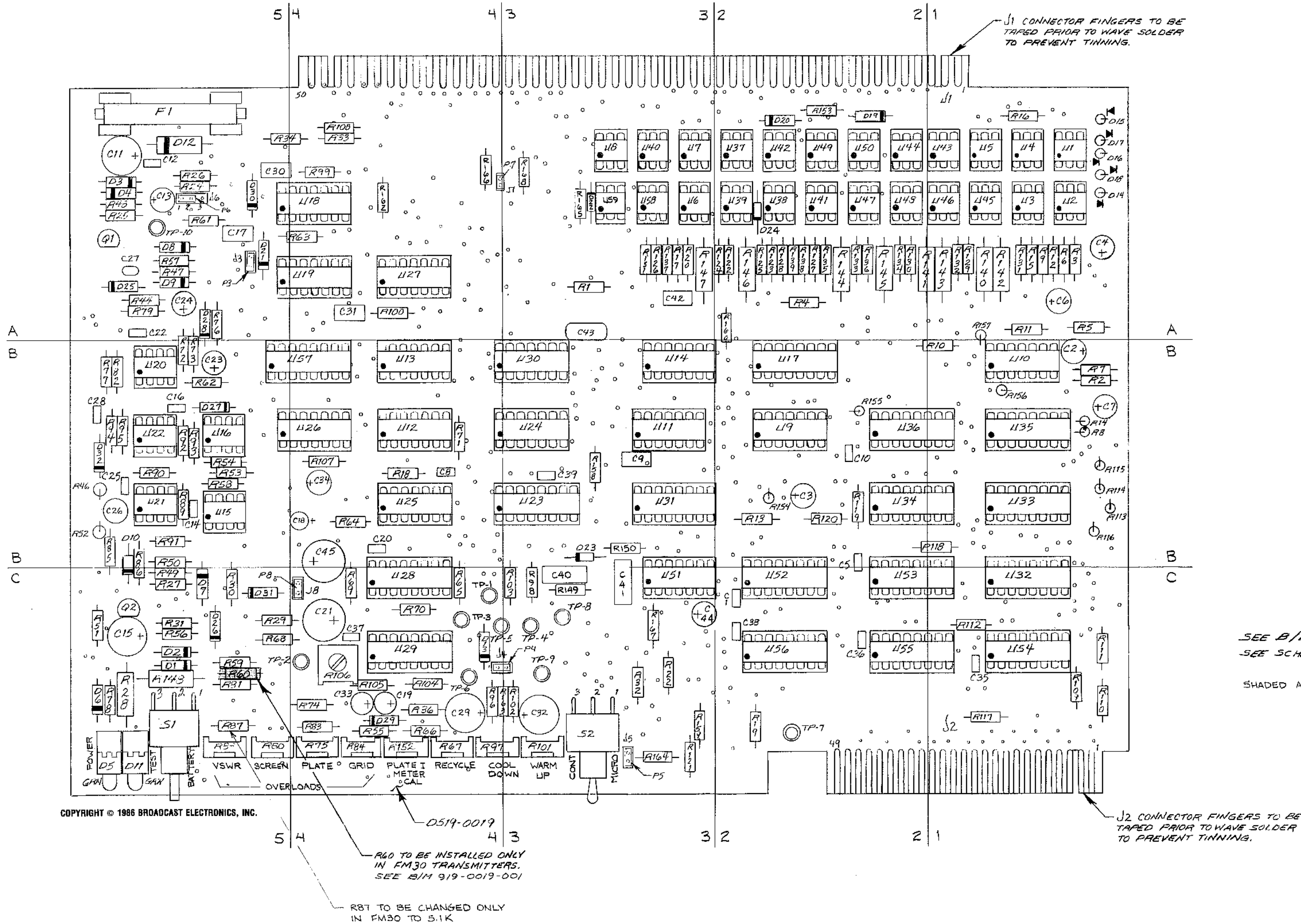
TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY MERKEL 5-5-83	MATERIAL	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST. QUINCY, IL 62305 217/224-9600 TELEX 250142 CABLE BCST ELECT QUI	
CHKD MH 5-18-83			
ME	FINISH	TITLE SCHEMATIC - PRIMARY TRANSMITTER CONTROLLER	
PROJ. ENGR.		TYPE S SIZE D DWG. NO. 919-0019	REV N
MFG.	NEXT ASSY. 959-0046	MODEL XMTRS SCALE	SHEET 1 OF 2



DWN. BY MERKEL 5-5-83	MATERIAL	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST. QUINCY, IL 62305 217/224-9600 TELEX 250142 CABLE BCST ELECT QUI	
CHKD MH 5-18-83			
ME	FINISH	TITLE SCHEMATIC - PRIMARY TRANSMITTER CONTROLLER	
PROJ. ENGR. 5-18-83		TYPE S SIZE D DWG. NO. 919-0019	REV N
MFG.	NEXT ASSY. 959-0046	MODEL XMTKS SCALE —	SHEET 2 OF 2

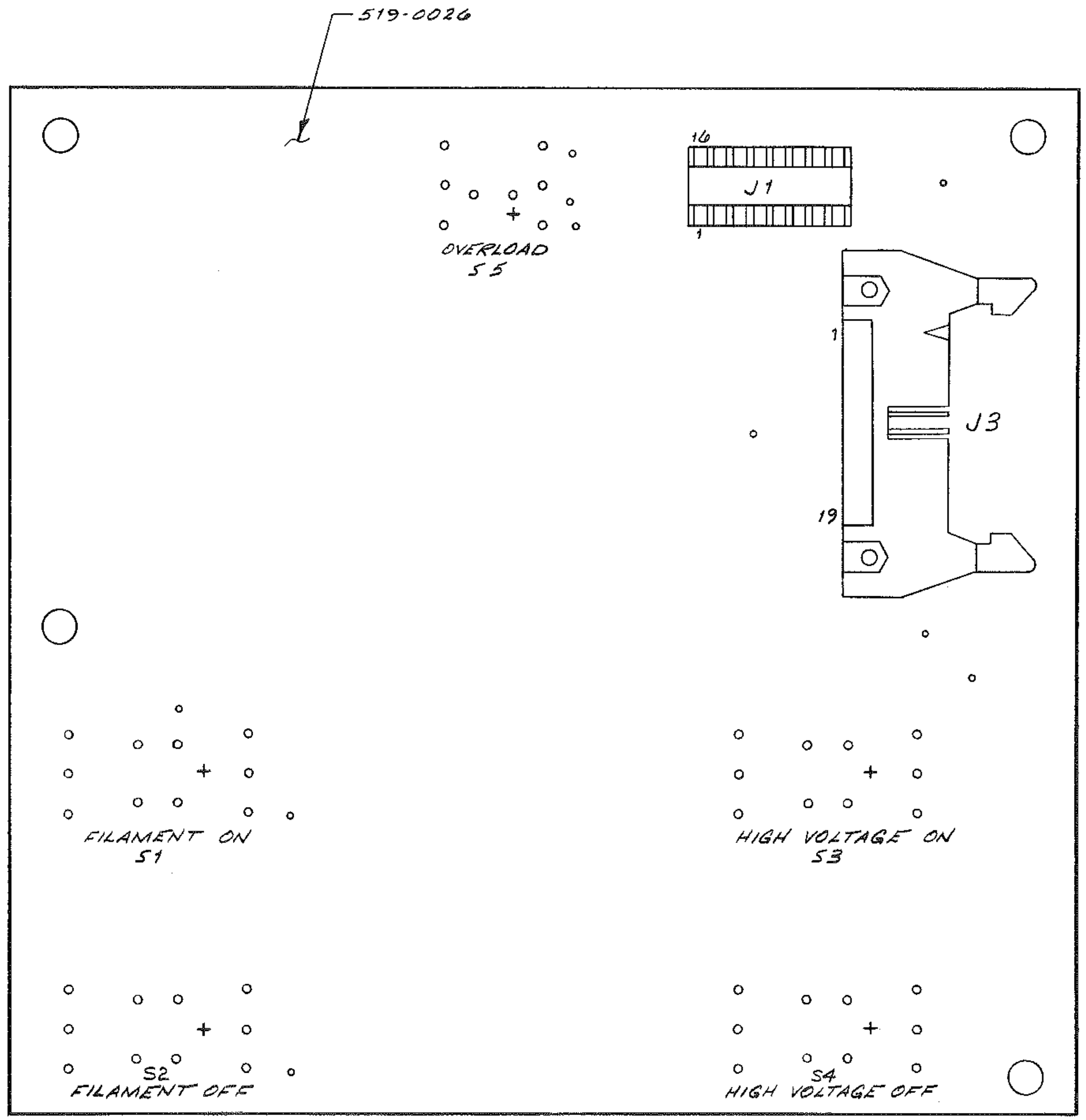
TOLERANCE (DECIMAL) U.O.S. .x ± .030 .xxx ± .005 .xx ± .015 ANGLES ± 1°



SEE B/M #919-0019 OR 919-0019-001 (FM30)
SEE SCHEMATIC #D919-0019

SHADED AREA LOCATED IN FM30 ONLY

TOLERANCE UNLESS OTHERWISE SPECIFIED DECIMAL 2 PL=.01 3PL=.005 FRACTIONAL ±1/64 ANGULAR ± 1° SHARP EDGES TO BEND RADII FILLET RADII	DRAWN BY CAF DATE 1-28-83 CHECKED BY DATE PROJECT ENGR. DATE 5-6-83 APPROVED BY MH 5-16-83	BROADCAST ELECTRONICS INC.	
MATERIAL	TREATMENT OR FINISH	TITLE ASSEMBLY PRIMARY TRANSMITTER CONTROLLER	
		D DWG. NO. A 919-0019 919-0019-001	REV. M
		SCALE 2/1 SHEET 1 OF 1	



NOTES:
1. WHEN INSTALLING SWITCHES, (+) TERMINAL MUST MATCH (+) INDICATOR ON PC BOARD.
2. SWITCHES ARE ADDED DURING FINAL DOOR ASSEMBLY.

REF ASSY # D959-0153
SEE SCHEMATIC # C959-0153
SEE B/M # 959-0153

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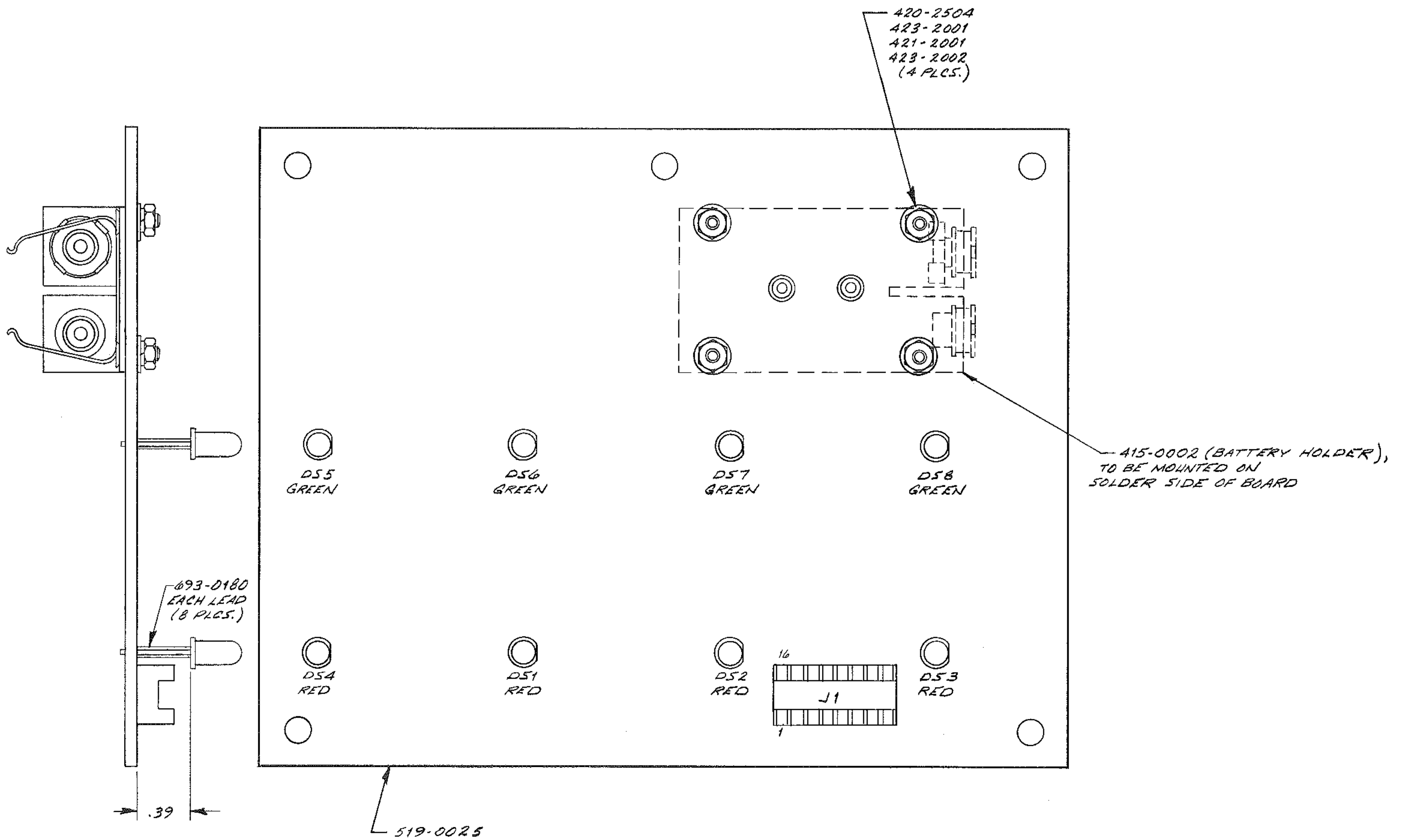

REF ASSY. # D959-0153
SEE SCHEMATIC # C959-0153
SEE B/M # 959-0153

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TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL

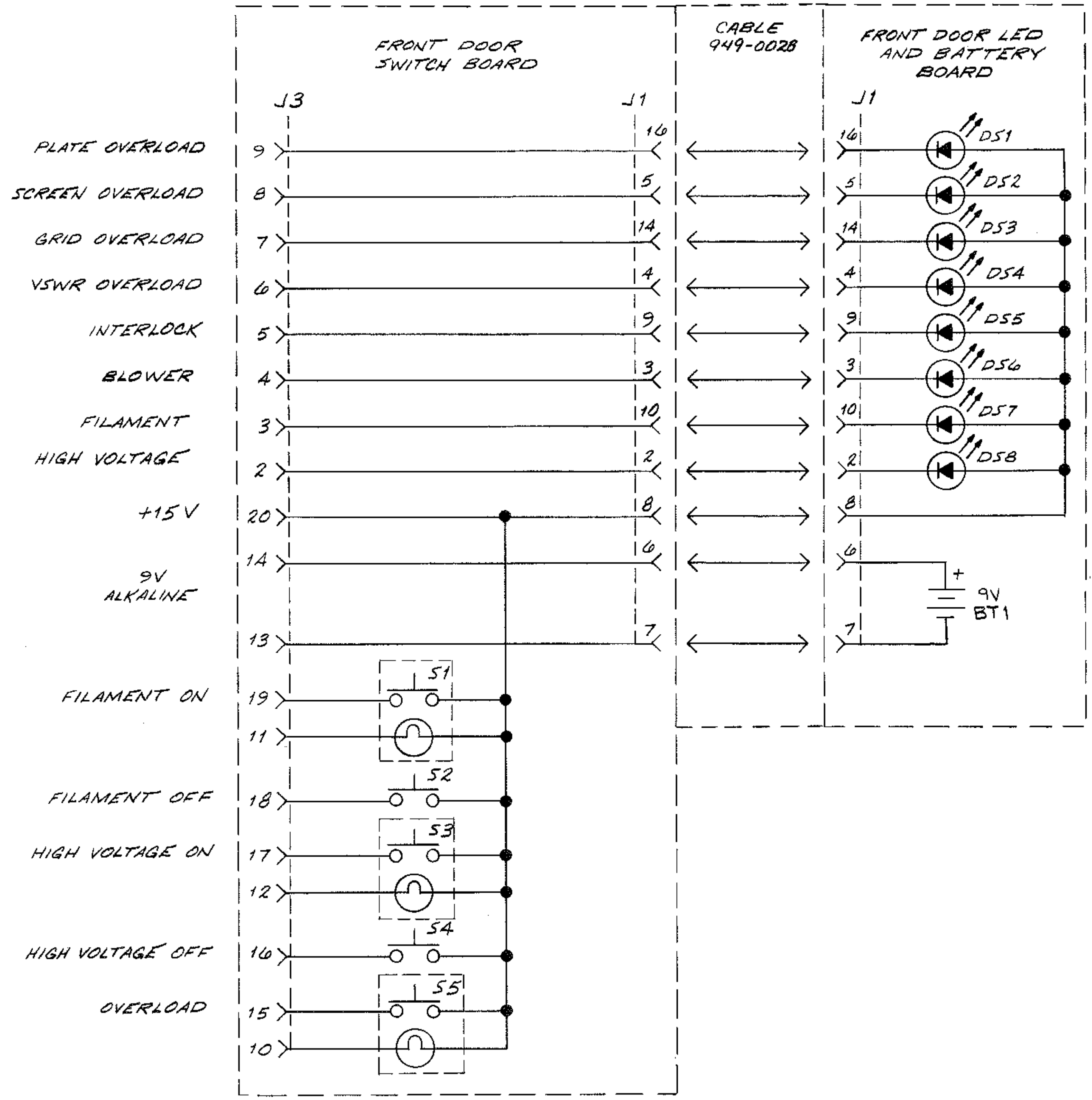
DRAWN BY MERK	DATE 12-11-82
CHECKED BY	DATE
PROJECT ENGR	DATE 5-13-83
APPROVED BY MH	5-13-83
TREATMENT OR FINISH	

BROADCAST ELECTRONICS INC.

TITLE PCB ASSEMBLY - CONTROLLER FRONT DOOR LED AND BATTERY

C DWG. NO. TYPE A 959-0153 REV. A

TRANSMITTERS SCALE 2/1 SHEET 1 OF 2



NOTES:

1. LAST COMPONENTS USED: DS8, J3, S5
2. SEE ASSEMBLY # C&D 959-0153
   #A949-0028

SEE B/M # 959-0153
949-0028

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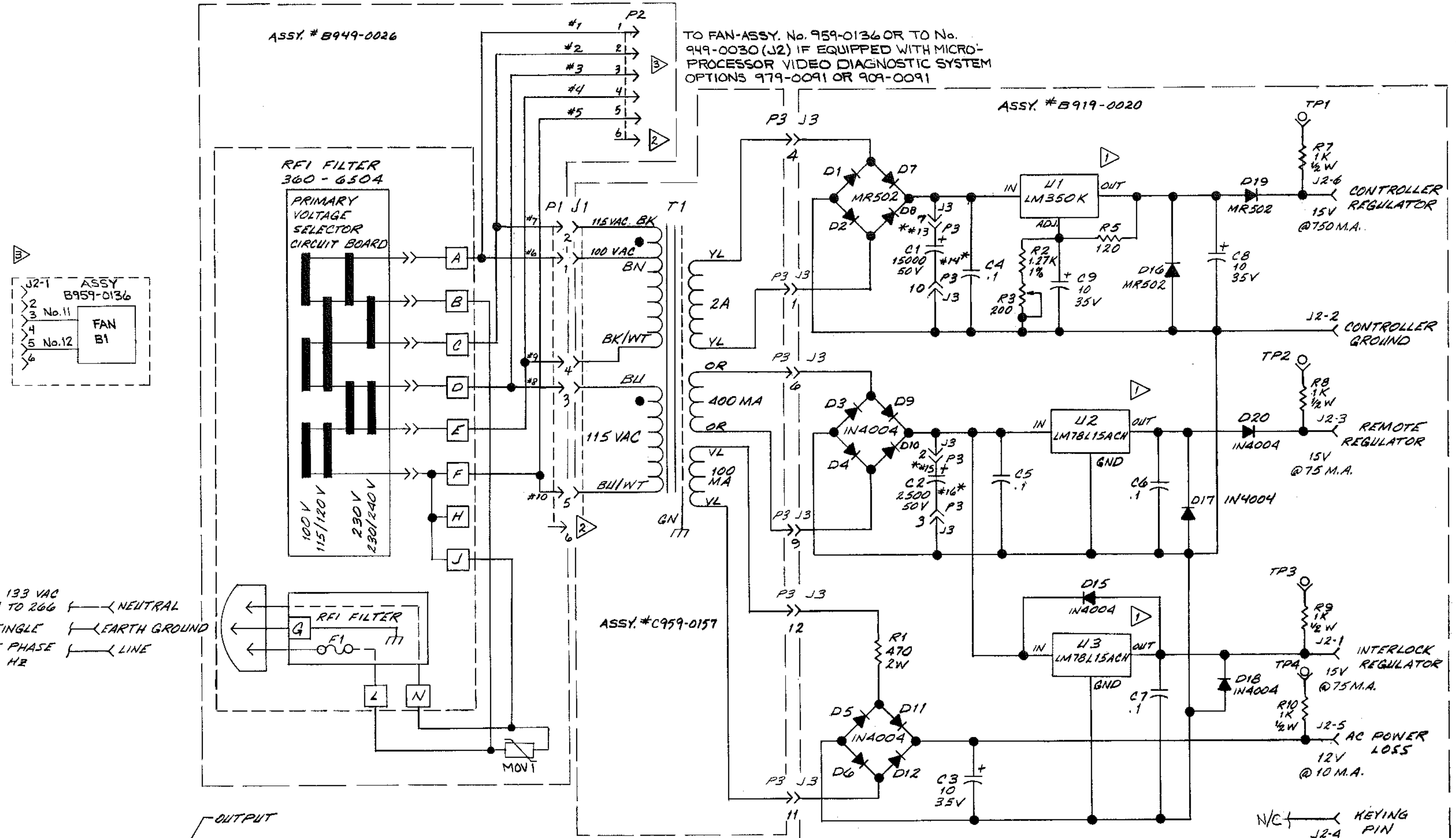
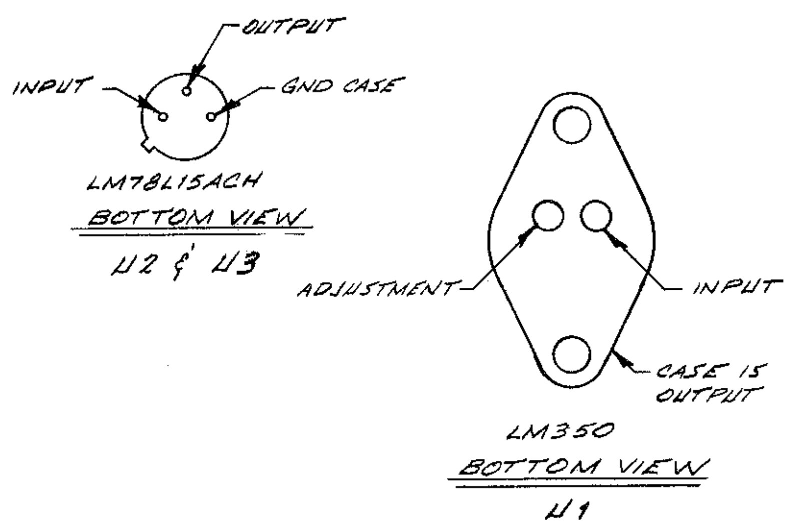
	CHKD.		
	ME	PRODUCT USED ON TRANSMITTER CONTROLLER	TITLE SCHEMATIC – FRONT DOOR SWITCH BD AND LED & BATTERY BD.
	EE		SHEET 1 OF 1
	PROJ. ENGR. 5-13-83	FINISH	SCALE — REV B
TOLERANCE (DECIMAL) U.O.S. .x ± .030 .xxx ± .005 .xx ± .015 ANGLES ± 1°	DFTG. SUPVR. 5-13-83 MH		TYPE S SIZE C DWG. NO. 959-0153
	MFG.		





1. ALL RESISTORS IN OHMS, 1/4 W; CAPACITORS IN MICROFARADS, U.O.S.
2. 1 — HEATSINK REQUIRED
3. LAST COMPONENTS USED: C9, D21, R10, T1, U3, J3, E10, & TP4
4. 2 POLARIZING PLUG # 418-0026
5. * WIRE #'s 13, 14, 15 & 16 ARE INCLUDED ON ASSY. # C959-0157.

SEE B/M's 919-0020, 959-0157, 949-0026 & 959-0045

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES
BEND RADII TO
FILLET RADII

MATERIAL

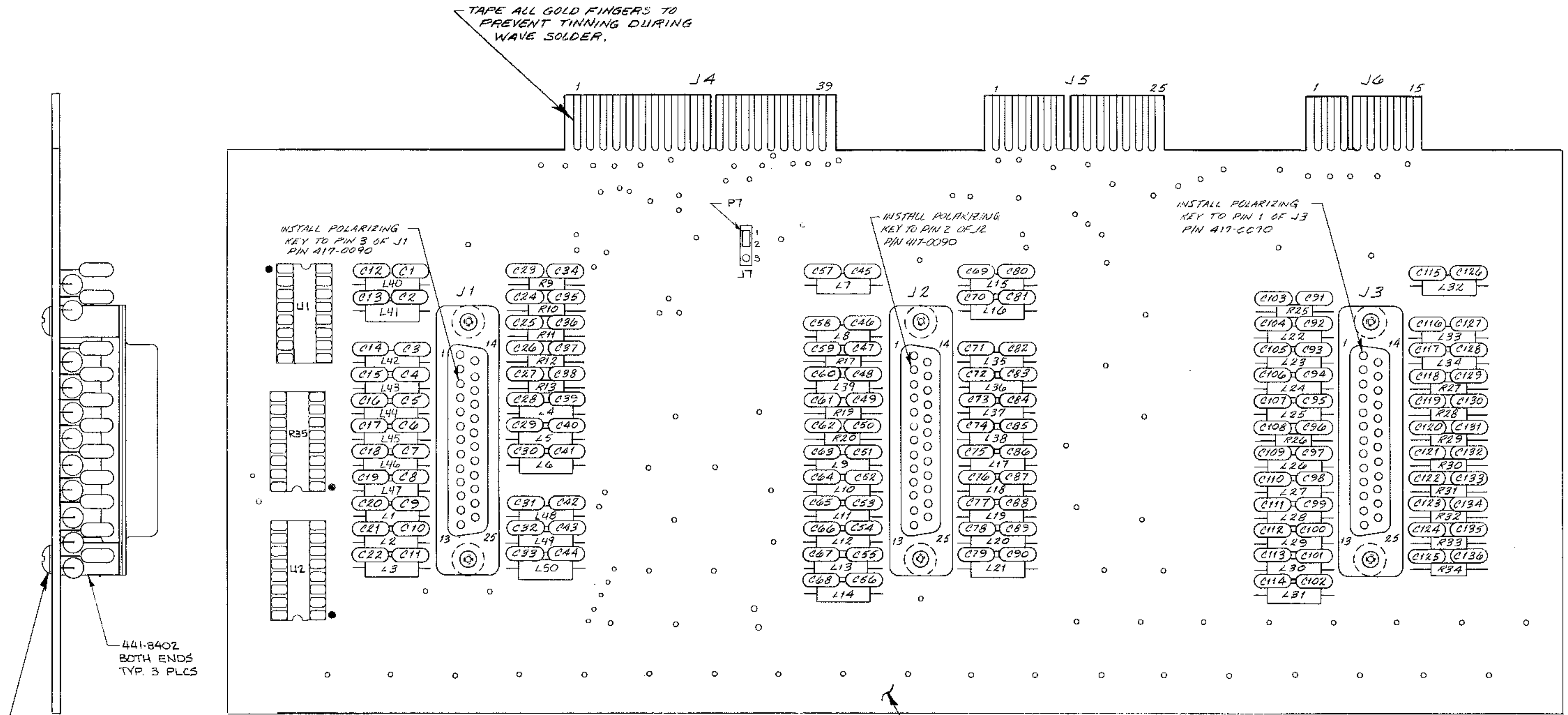
DRAWN BY MERK DATE 9-24-82
CHECKED BY DATE
PROJECT ENGR DATE 5-16-83
APPROVED BY MH 5-16-83
TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.

TITLE SCHEMATIC — TRANSMITTER CONTROLLER POWER SUPPLY

C DWG. NO. 959-0045 REV. C

SCALE NTS SHEET 1 OF 1

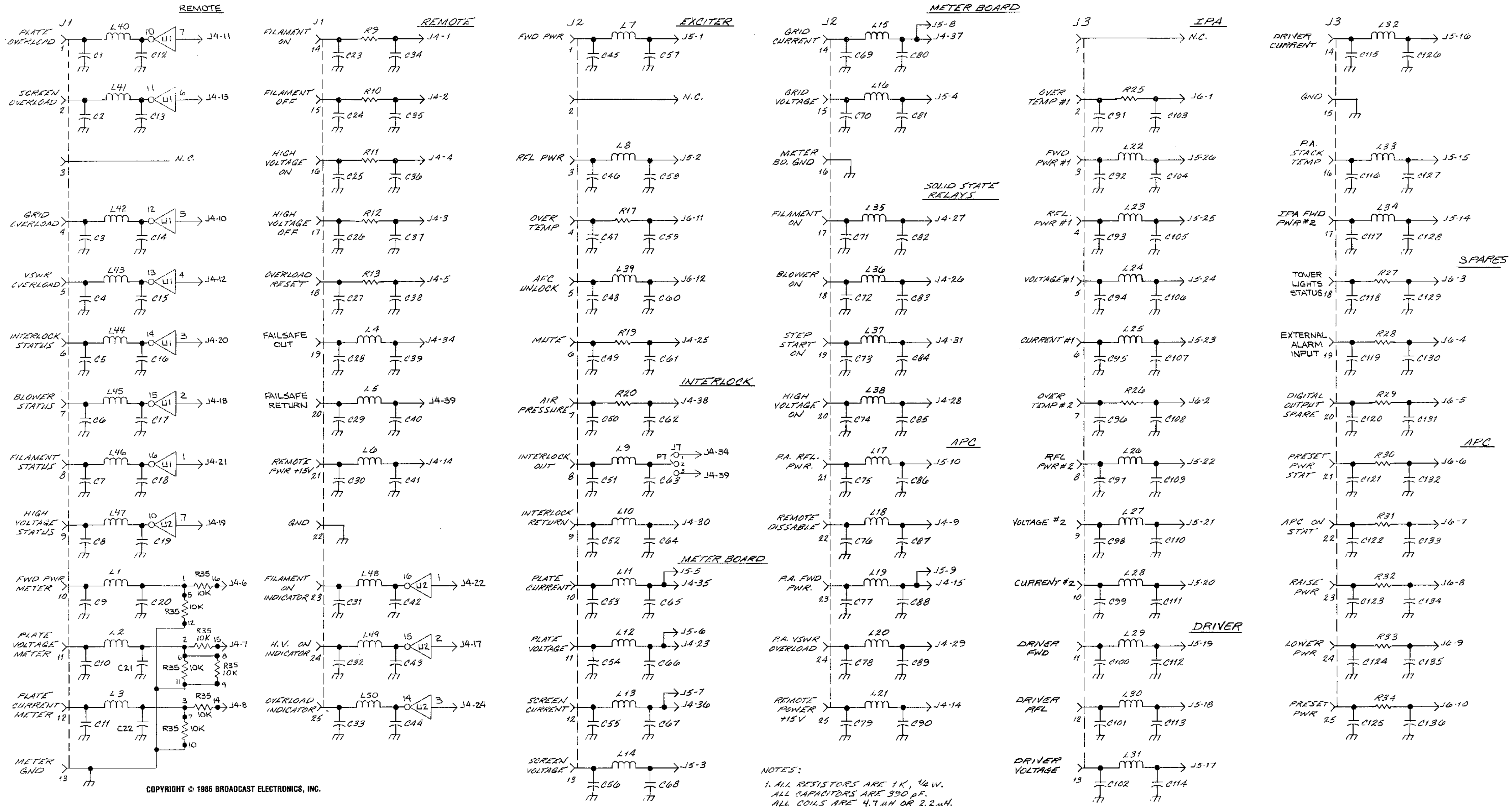


NOTE:
INSERT HARDWARE INTO PCB FROM COMPONENT SIDE. TAPE HARDWARE HOLES ON CIRCUIT SIDE OF PCB TO PREVENT FILLING DURING WAVE SOLDER. AFTER WAVE SOLDER, REMOVE HARDWARE FROM COMPONENT SIDE AND INSERT INTO CIRCUIT SIDE OF PCB.

SEE SCHEMATIC # D919-0056
SEE B/M # 919-0056

NOTE:
1. L1-L39 MAY BE EITHER 2.2 μH OR 4.7 μH UNDER P/N 360-0022.
2. FOR MOSLEY REMOTE CONTROL SYSTEMS, REPLACE U1, U2 & R35 WITH JUMPERS P/N 360-0006. INSTALL JUMPER AT PIN 1 POSITION OF R35.

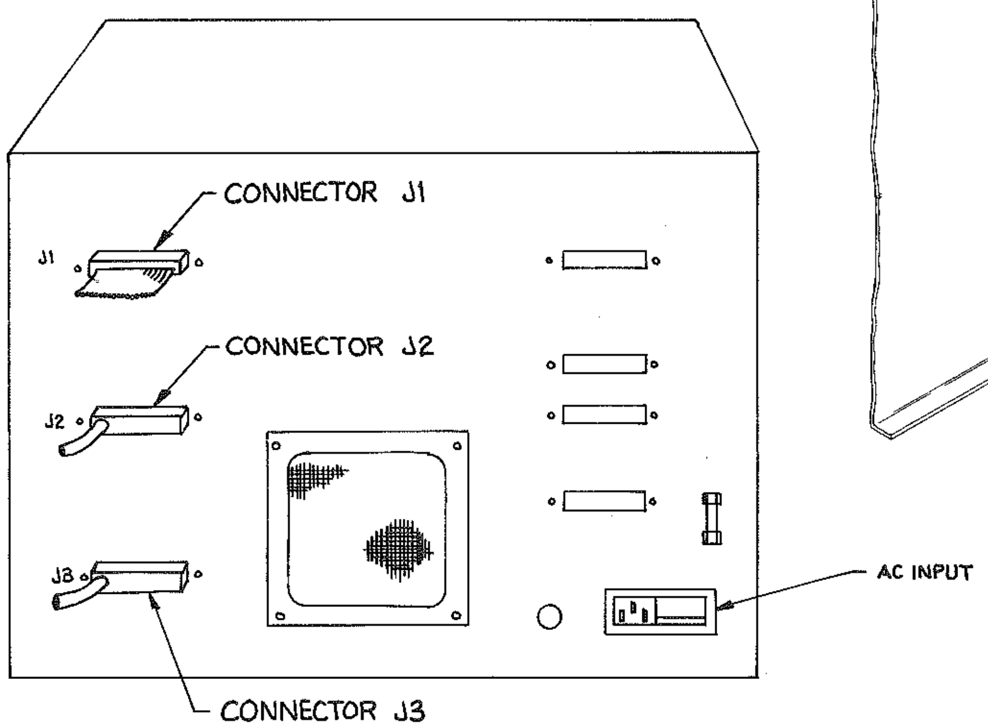
TOLERANCE UNLESS OTHERWISE SPECIFIED DECIMAL 2 PL=.01 3PL=.005 FRACTIONAL ±1/64 ANGULAR ± 1° SHARP EDGES TO BEND RADII FILLET RADII	DRAWN BY Mekall	DATE 1-20-83	BROADCAST ELECTRONICS INC.
	CHECKED BY	DATE	TITLE PCB ASSEMBLY - TRANSMITTER CONTROLLER INPUT FILTER BD.
	PROJECT ENGR	DATE	
	APPROVED BY MH	5-13-83	D DWG. NO. TYPE A 919-0056 REV. E
MATERIAL	TREATMENT OR FINISH		TRANSMITTER CONTROLLER / SCALE 2/1 / SHEET 1 OF 1



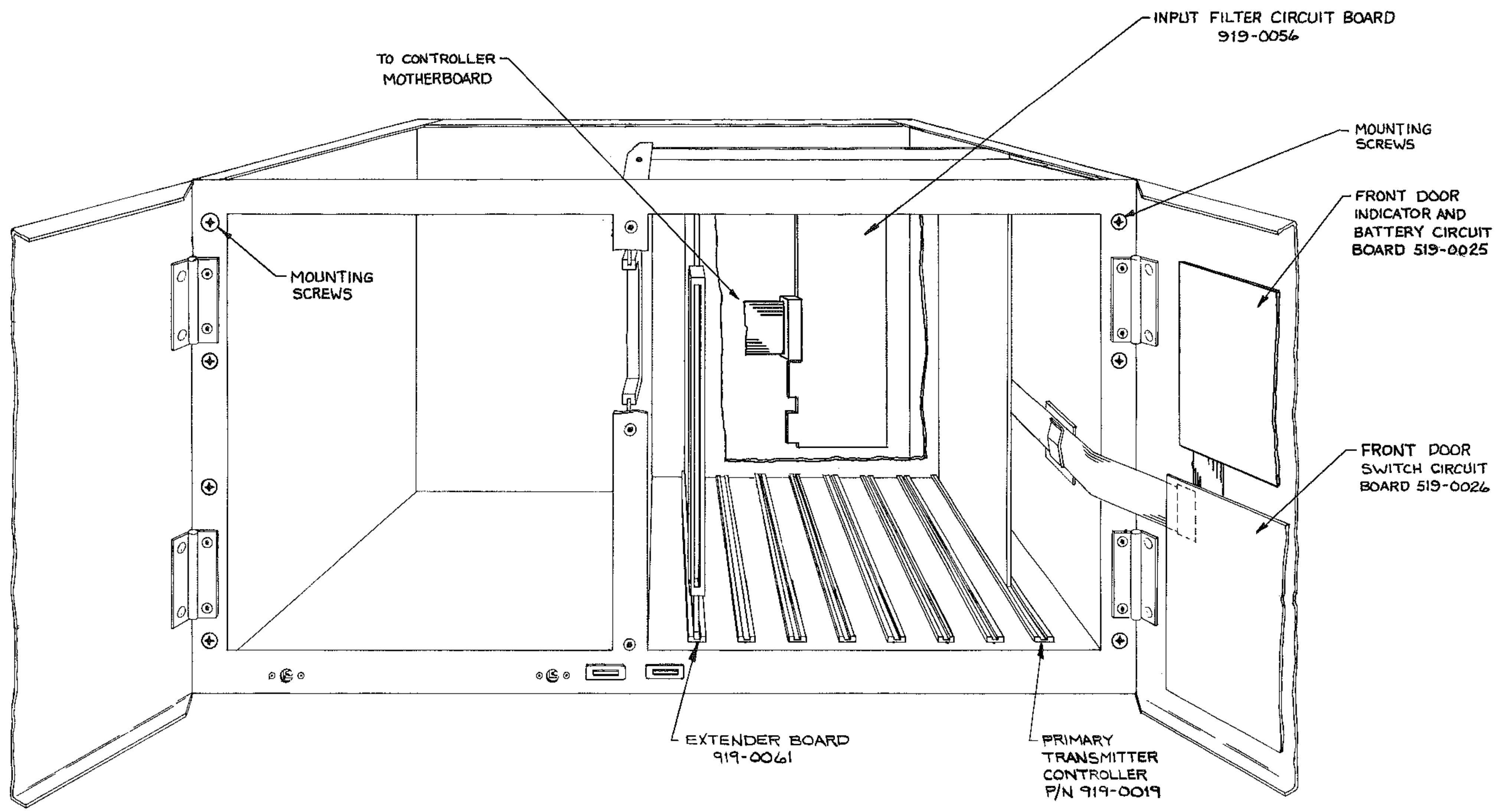
NOTES:

1. ALL RESISTORS ARE 1K, 1/4 W.
   ALL CAPACITORS ARE 390 pF.
   ALL COILS ARE 4.7 uH OR 2.2 uH.
2. LAST COMPONENTS USED: C136, L39, R35, U2, J7
3. COMPONENTS NOT USED: R18
   SEE ASSEMBLY # D919-0056
   SEE B/M # 919-0056
4. ON J7, CONNECT 1 TO 2 FOR INDEPENDENT FAILSAFE INTERLOCK STRING OR CONNECT 2 TO 3 FOR SERIAL FAILSAFE INTERLOCK. INDEPENDENT FAILSAFE INTERLOCK REQUIRES REVISION C OR LATER PRIMARY TRANSMITTER CONTROLLER BOARD.

TOLERANCE UNLESS OTHERWISE SPECIFIED	DECIMAL 2 PL=.01 3PL=.005 FRACTIONAL ±1/64 ANGULAR ± 1° SHARP EDGES TO BEND RADII FILLET RADII
MATERIAL	
DRAWN BY	MERKEL
DATE	4-21-83
CHECKED BY	
PROJECT ENGR.	
DATE	5-13-83
APPROVED BY	MH
DATE	5-13-83
TREATMENT OR FINISH	
	BROADCAST ELECTRONICS INC.
TITLE	SCHEMATIC - TRANSMITTER CONTROLLER INPUT FILTER BD.
SIZE	D
DWG. NO.	919-0056
REV.	G
	TRANSMITTER CONTROLLER
SCALE	2:1
SHEET	1 OF 1



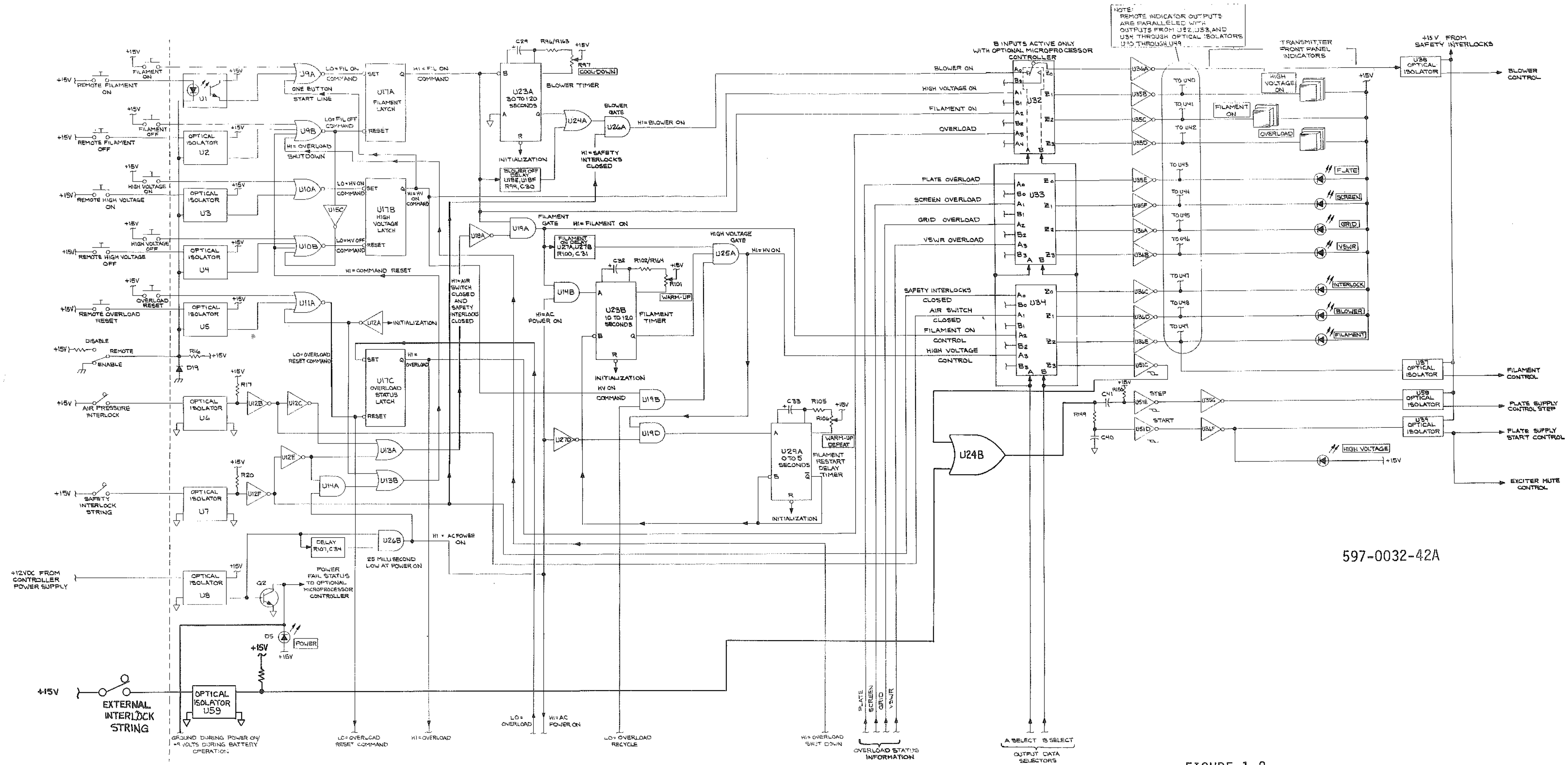
REAR PANEL VIEW



— CAUTION —
COMPONENT SIDE OF ALL CIRCUIT BOARDS TO LEFT

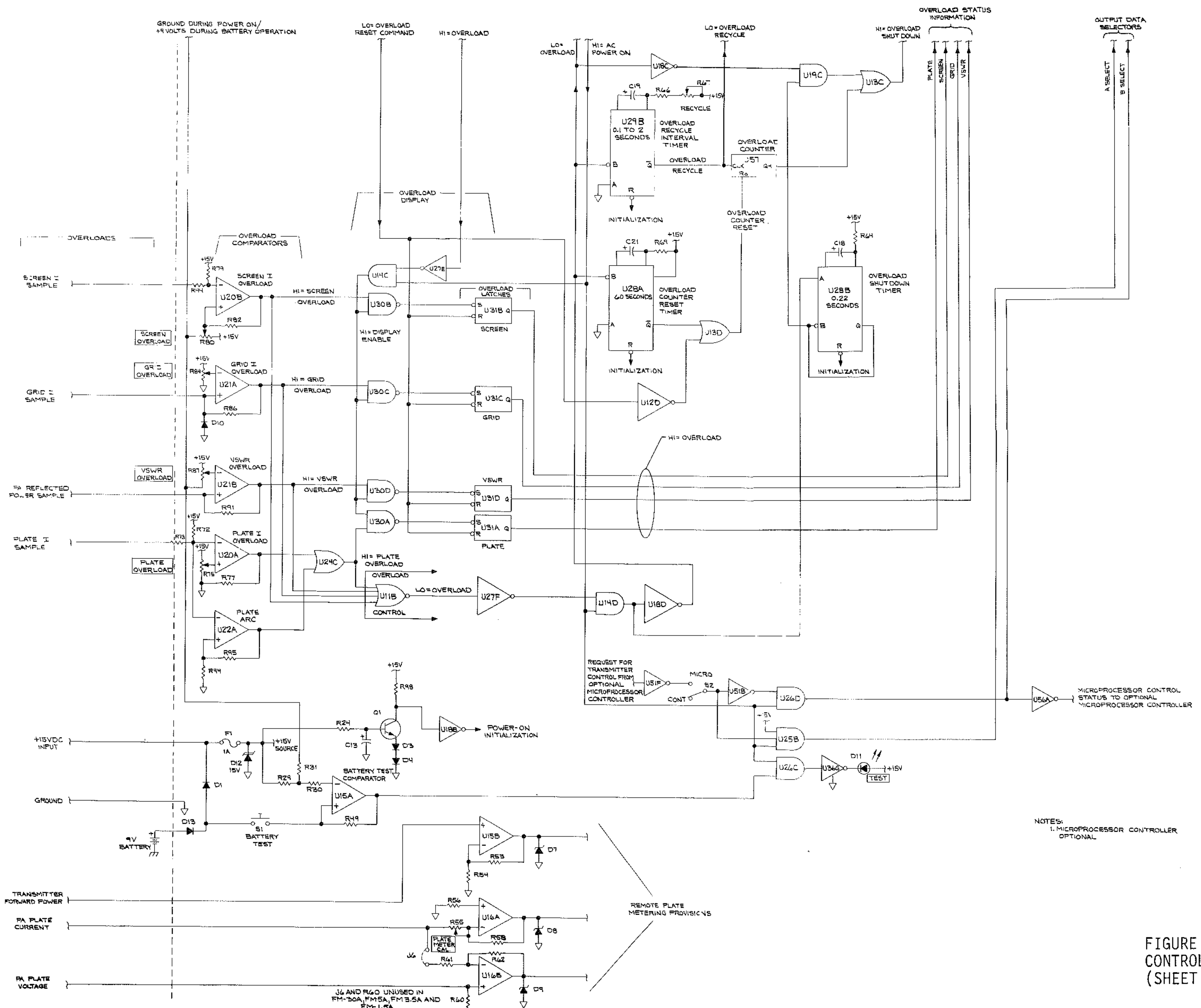
597-0032-105

FIGURE 3-1. ASSEMBLY, CONTROLLER CABINET



597-0032-42A

FIGURE 1-2.
CONTROLLER CIRCUIT BOARD SIMPLIFIED SCHEMATIC
(SHEET 1 OF 2)



597-0032-42B

FIGURE 1-2.
CONTROLLER CIRCUIT BOARD SIMPLIFIED SCHEMATIC
(SHEET 2 OF 2)

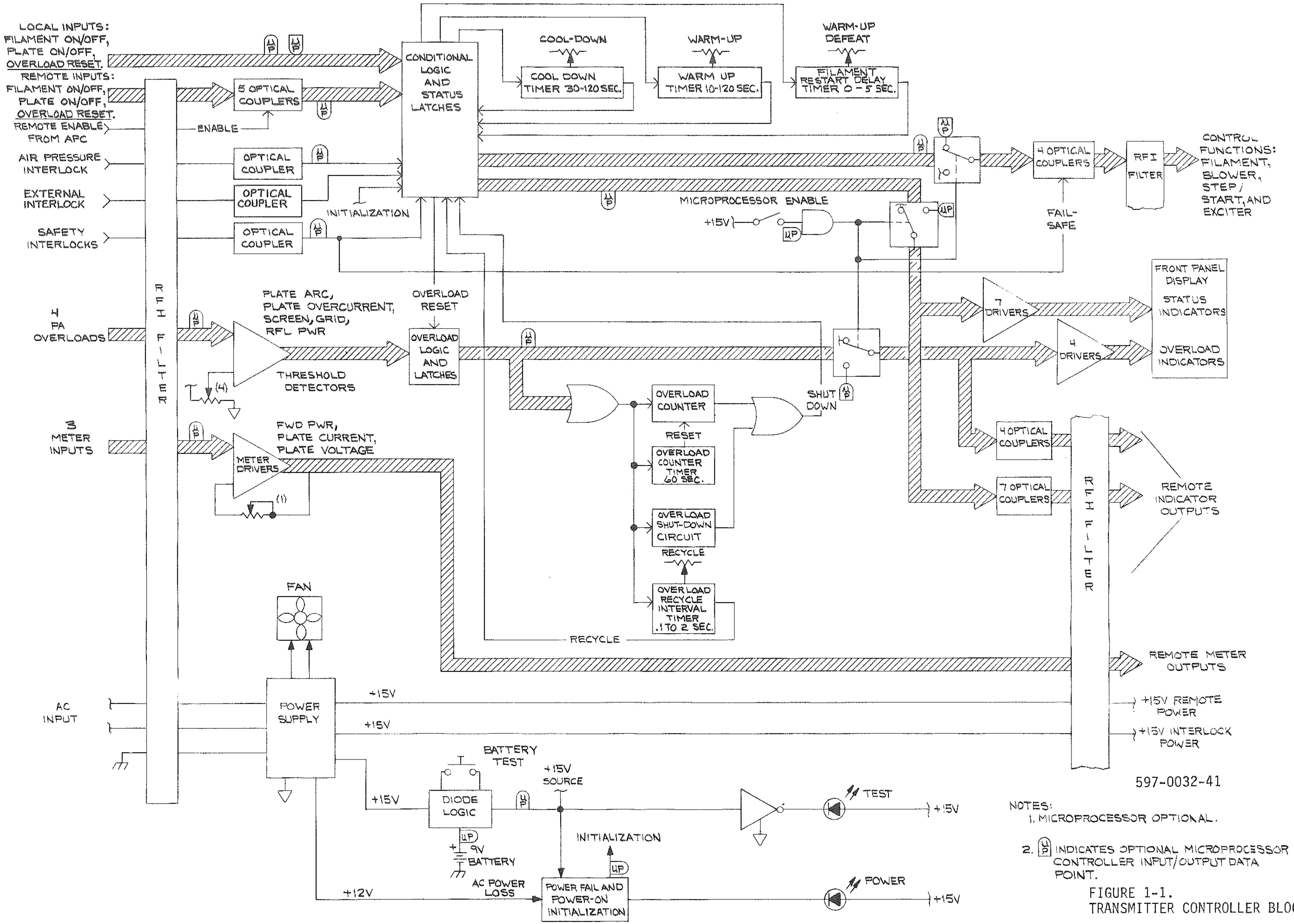
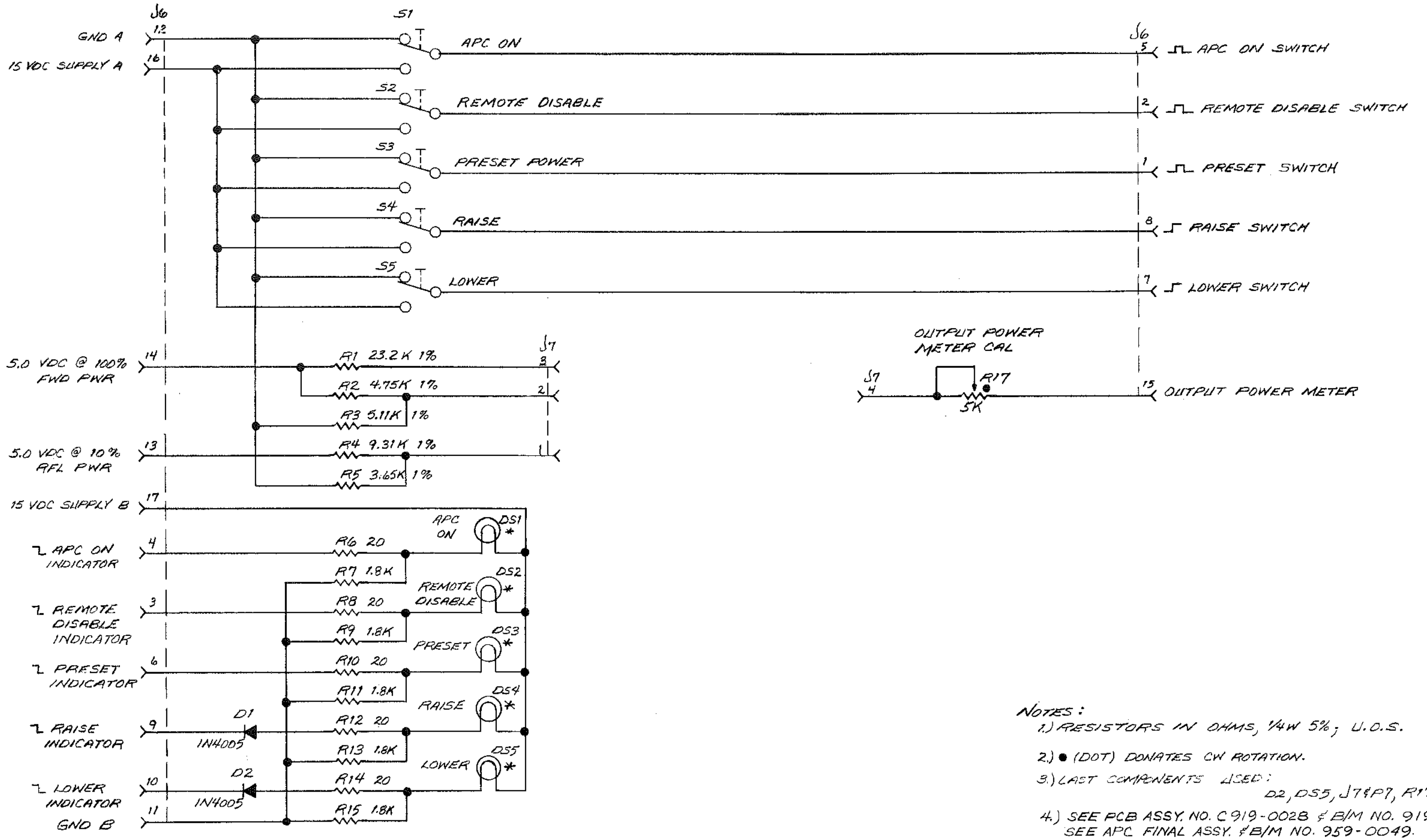


FIGURE 1-1.
TRANSMITTER CONTROLLER BLOCK DIAGRAM



NOTES:

1.) RESISTORS IN OHMS, 1/4W 5%; U.O.S.

2.) ● (DOT) DONATES CW ROTATION.

3.) LAST COMPONENTS USED:
D2, DS5, J7 & P7, R17, S6

4.) SEE PCB ASSY. NO. C919-0028 & B/M NO. 919-0028.
SEE APC FINAL ASSY. & B/M NO. 959-0049.
SEE OVERALL SCHEMATIC NO. D959-0049.

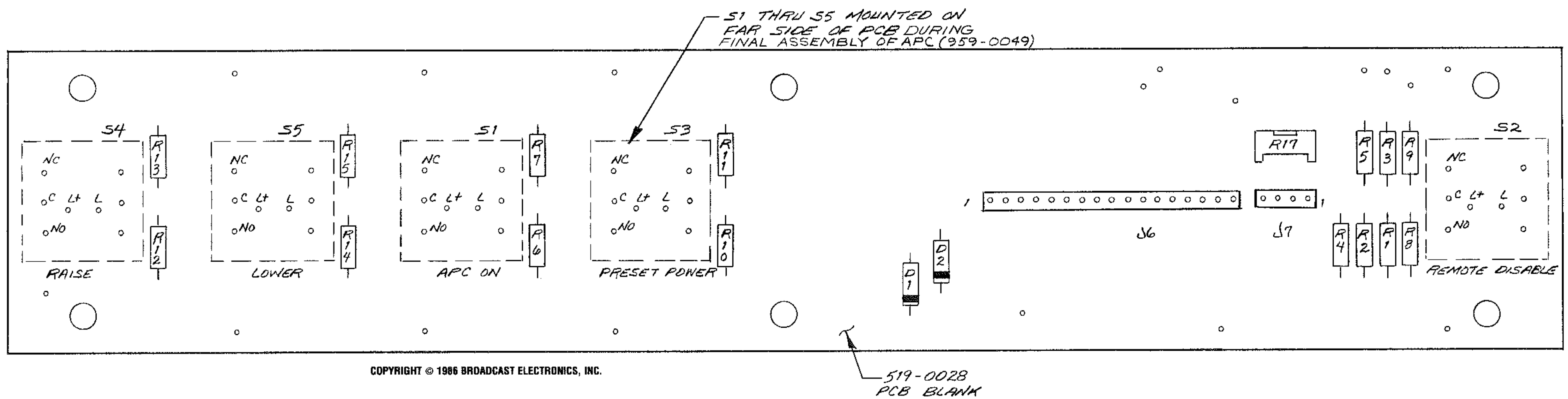
* 5.) DS1 THRU DS5 ARE LICON #80-011364 IND. STD. #73
14 V, 15,000 HR.
DS1 IS LOCATED WITHIN S1, DS2 IS LOCATED WITHIN S2 AND SO ON.

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL

TREATMENT OR FINISH

DRAWN BY ORF	DATE 12-14-82	BROADCAST ELECTRONICS INC.
CHECKED BY	DATE	
PROJECT ENGR. JMD	DATE 5/5/83	TITLE SCHEMATIC APC FRONT PANEL PCB ASSEMBLY
APPROVED BY MH	5-6-83	C DWG. NO. TYPE: S 919-0028 — REV. B
		APC (959-0049) — SCALE N/S — SHEET 1 OF 1

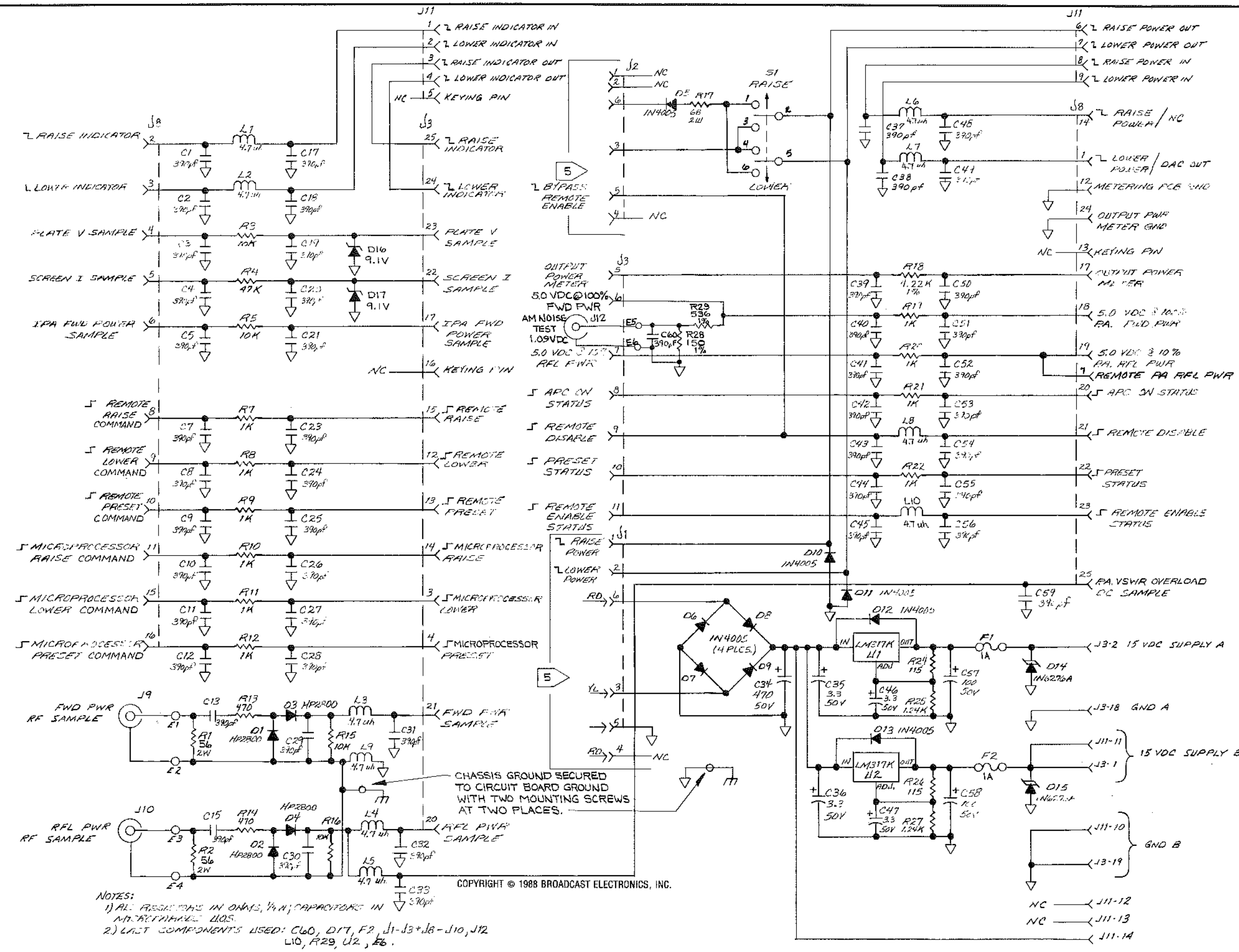


NOTE: J6 & J7 ARE MADE FROM 417-0200.

SEE SCHEMATIC C919-0028
SEE B/M 919-0028

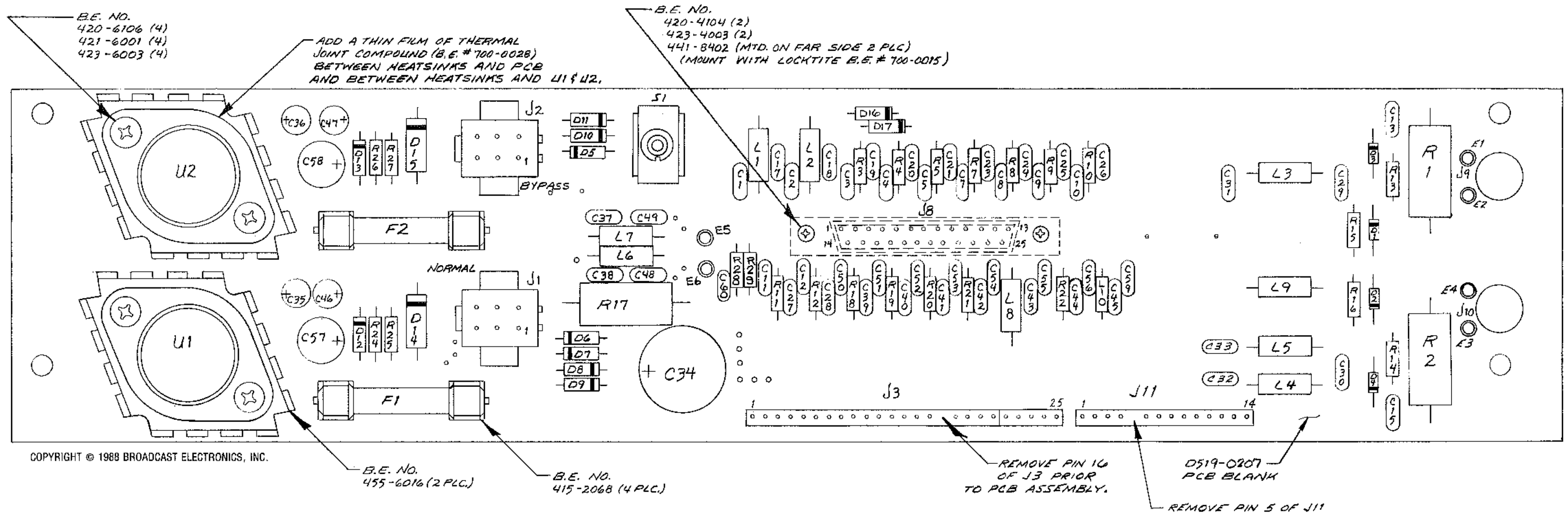
TOLERANCE (DECIMAL) U.O.S.
.X ± .030 .XXX ± .005
.XX ± .015 ANGLES ± 1°

DWN. BY M.J. ORF		NEXT ASSY. 959-0049	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST. QUINCY, IL 62305 217/224-9600 TELEX 250142 CABLE BCST ELECT QUI
CHKD.		PRODUCT USED ON APC	
ME			TITLE PCB ASSEMBLY APC FRONT PANEL
EE [signature]	5/5/83	FINISH	SHEET 1 OF 1
PROJ. ENGR. [signature]	5/5/83		SCALE 2/1 / REV B
DFTG. SUPVR. MH	5-6-83		TYPE A / SIZE C / DWG. NO. 919-0028
MFG.			



NOTES:
1) ALL RESISTORS IN OHMS, 1/4 W; CAPACITORS IN MICROFARADS UOS.
2) LAST COMPONENTS USED: C60, D17, F2, J1-J3+J8-J10, J12, L10, R29, U2, E6.
3) COMPONENTS NOT USED: C6, R6, C22, R23, C14, C16.
4) SEE B/M 919-0207
5.) FOR NORMAL APC OPERATION, PLUG P1 MUST BE CONNECTED TO RECEPTACLE J1. PLUG P1 IS CONNECTED TO P2 ONLY TO ALLOW MANUAL EMERGENCY BACKUP OPERATION.
6.) L1-L10 MAY BE EITHER 2.2 OR 4.7 μH AS P/N 360-0022

TOLERANCE UNLESS OTHERWISE SPECIFIED DECIMAL 2 PL=.01 3PL=.005 FRACTIONAL ±1/64 ANGULAR ±1° SHARP EDGES TO BEND RADII FILLET RADII	DRAWN BY JAH DATE 1-19-88	BROADCAST ELECTRONICS INC.	
MATERIAL	CHECKED BY DATE	TITLE SCHEMATIC APC REAR PANEL PCB	
	PROJECT ENGR. DATE	D DWG. NO. 919-0207	REV. B
	APPROVED BY	APC	SCALE — SHEET 1 OF 1
	TREATMENT OR FINISH		



SEE SCHEMATIC #D919-0207
SEE B/M #919-0207

NOTE:
1. L1- L10 MAYBE EITHER 2.2 OR 4.7 μH AS P/N 360-0022
2. J3 & J11 ARE MADE FROM 417-0200.

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL

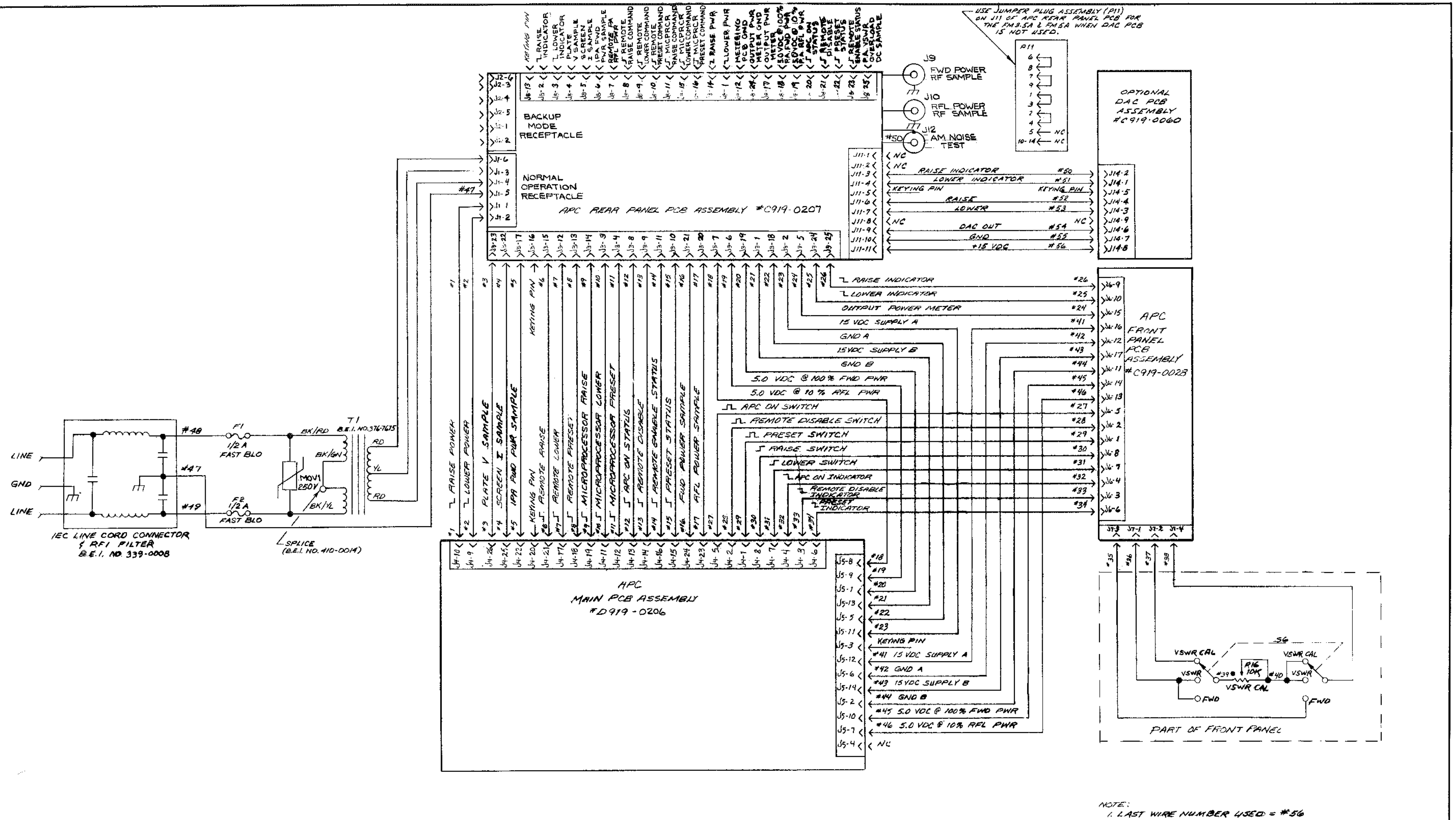
DRAWN BY JAH DATE 1-1988
CHECKED BY DATE
PROJECT ENGR. DATE 1-1988
APPROVED BY
TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.

TITLE PCB ASSEMBLY APC REAR PANEL

D DWG. NO. A 919-0207 REV. E

APC SCALE 2/1 SHEET 1 OF 1



NOTE:
1. LAST WIRE NUMBER USED = #56

TOLERANCE UNLESS OTHERWISE SPECIFIED DECIMAL 2 PL=.01 3PL=.005 FRACTIONAL ±1/64 ANGULAR ± 1° SHARP EDGES TO BEND RADII FILLET RADII	DRAWN BY JAH	DATE 2-5-88	BROADCAST ELECTRONICS INC.
	CHECKED BY	DATE	TITLE SCHEMATIC APC OVERALL
	PROJECT ENGR.	DATE 2-5-88	D DWG. NO. TYPE S 959-0243 REV. A
MATERIAL	APPROVED BY / TREATMENT OR FINISH		SCALE N-S SHEET 1 OF 1

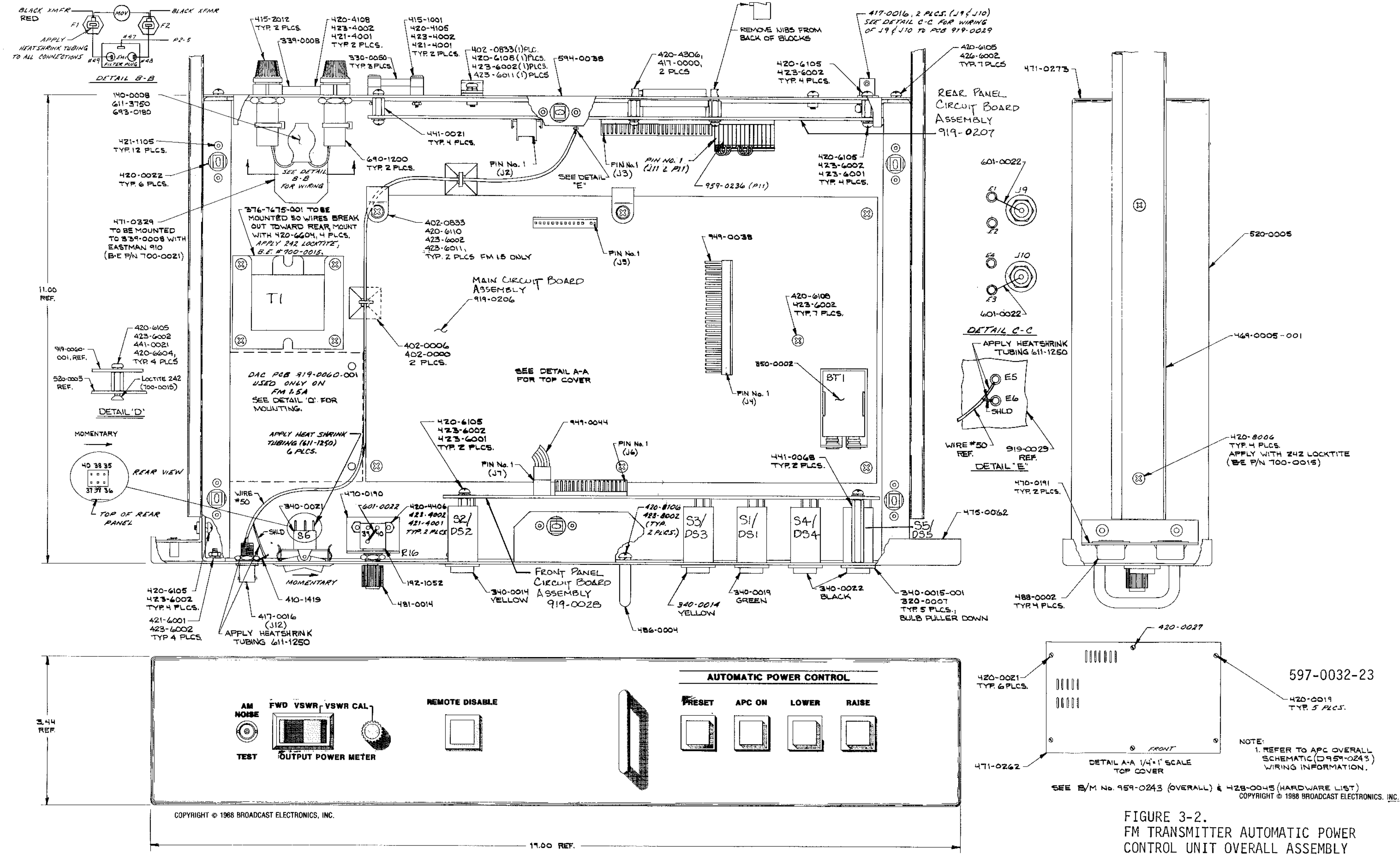
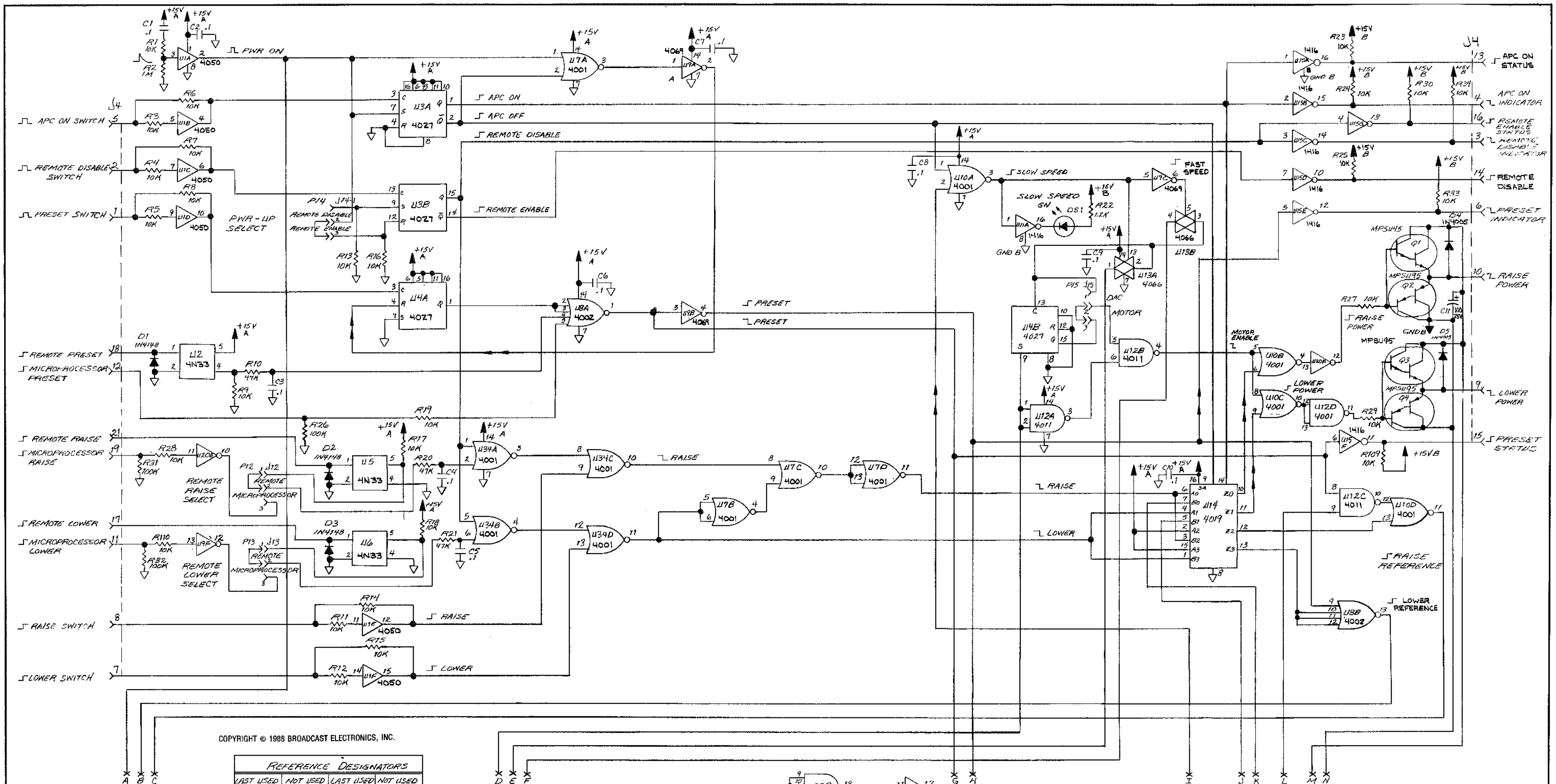


FIGURE 3-2.
FM TRANSMITTER AUTOMATIC POWER CONTROL UNIT OVERALL ASSEMBLY



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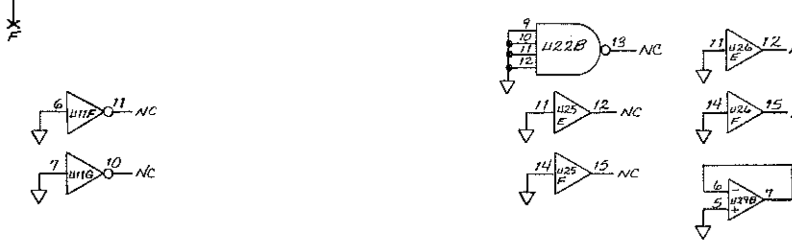
REFERENCE DESIGNATORS			
LAST USED	NOT USED	LAST USED	NOT USED
C39	U29-B	DS5	U26-E,F
D17	U11-F,G	TP1	R36, R37
J15		BT1	R48, R50
Q8			R70, R71
R113	U22-B		R85, R88
U34	U25-E,F		R95, R97
			R98



NOTE:
1. RESISTORS IN OHMS, 1/4 W 5%; CAPACITORS IN MICROFARADS, U.O.S.
2. SEE PCB ASSY. #D919-0206
SEE B/M #919-0206

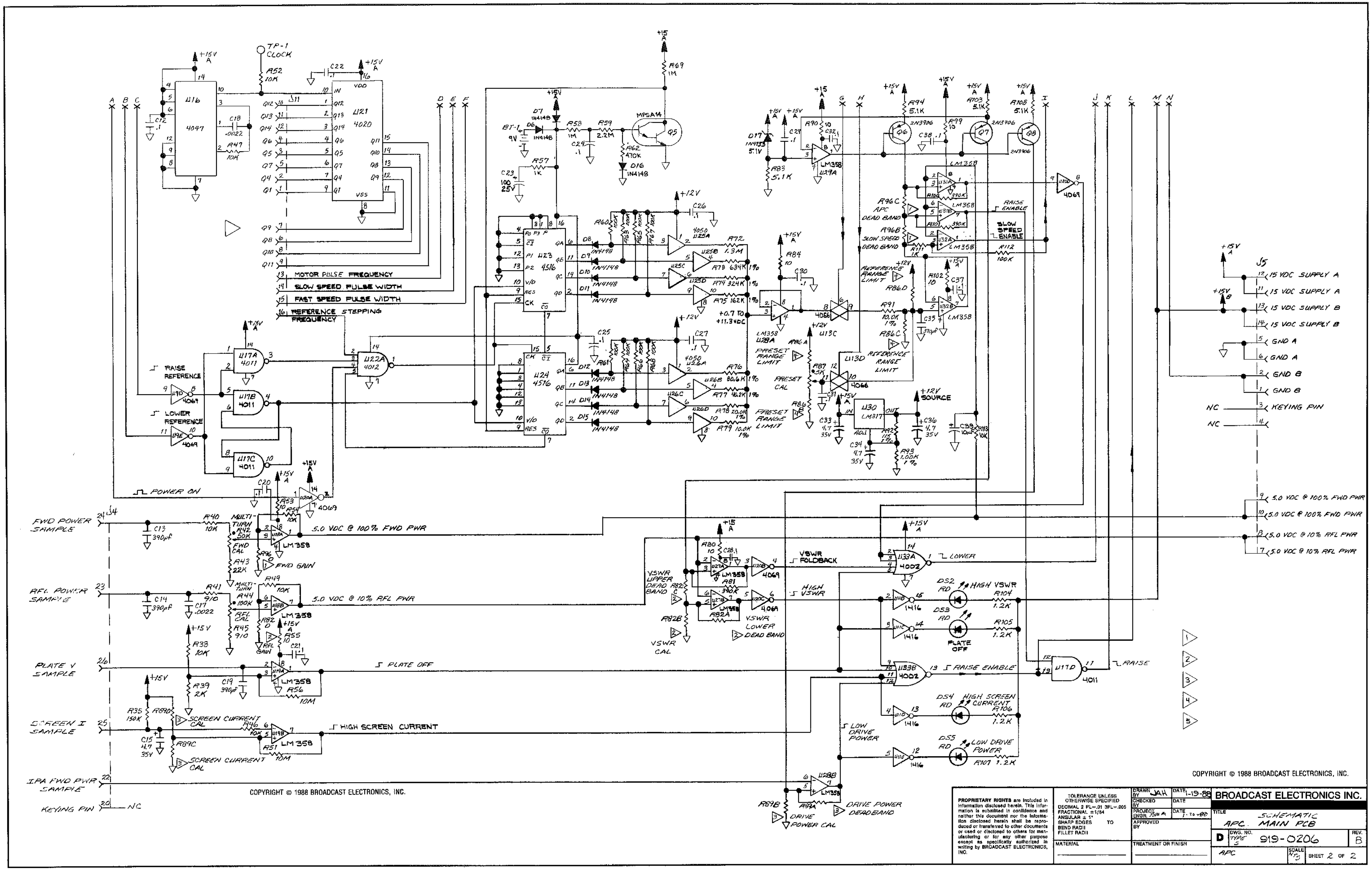
REFERENCE DESIGNATORS	U1, U25 & U26	U2, U5, & U6	U3 & U4	U7, U10 & U34	U8 & U33	U9 & U20	U11 & U15	U12 & U17	U13	U14	U16	U18, U19, U27 - U29, U31 & U32	U21	U22	U23 & U24	U30
B.E. PART NO.	228-4050	229-0033	225-0003	228-4001	228-4002	228-4069	226-2004	228-4011	225-0004	228-4019	220-4047	221-0358	228-4020	228-4012	228-4516	227-0317
VENDOR PART NO.	4050	4N33	4027	4001	4002	4069	MC1416	4011	4066	4019	4047	LM358	4020	4012	4516	LM317T
VOLTAGE PIN NO.	1	———	16	14	14	14	———	14	14	16	14	8	16	14	16	———
GROUND PIN NO.	8	———	8	7	7	7	8	7	7	8	7	4	8	7	8	———

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL

DRAWN BY JAH DATE 1-1988
CHECKED BY DATE
PROJECT ENGR. DATE 1-26-88
APPROVED BY
TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.
TITLE SCHEMATIC APC MAIN PCB
D DWG. NO. TYPE S 919-0206 REV. B
APC SCALE NTS SHEET 1 OF 2



TP-1 CLOCK
MOTOR PULSE FREQUENCY
SLOW SPEED PULSE WIDTH
FAST SPEED PULSE WIDTH
REFERENCE STEPPING FREQUENCY
RAISE REFERENCE
LOWER REFERENCE
POWER ON
FWD POWER SAMPLE
RFL POWER SAMPLE
PLATE V SAMPLE
SCREEN I SAMPLE
IPA FWD PWR SAMPLE
KEYING PIN
NC
5.0 VDC @ 100% FWD PWR
5.0 VDC @ 10% RFL PWR
FWD GAIN
PLATE OFF
HIGH SCREEN CURRENT
SCREEN CURRENT CAL
APC DEAD BAND
SLOW SPEED DEAD BAND
RAISE ENABLE
SLOW SPEED ENABLE
REFERENCE RANGE LIMIT
PRESET RANGE LIMIT
PRESET CAL
+12V SOURCE
VSWR UPPER DEAD BAND
VSWR CAL
VSWR FOLDBACK
HIGH VSWR
VSWR LOWER DEAD BAND
LOWER
PLATE OFF
HIGH SCREEN CURRENT
LOW DRIVE POWER
RAISE ENABLE
RAISE
DRIVE POWER CAL
DRIVE POWER DEADBAND
15 VDC SUPPLY A
15 VDC SUPPLY A
15 VDC SUPPLY B
15 VDC SUPPLY B
GND A
GND A
GND B
GND B
KEYING PIN
5.0 VDC @ 100% FWD PWR
5.0 VDC @ 100% FWD PWR
5.0 VDC @ 10% RFL PWR
5.0 VDC @ 10% RFL PWR
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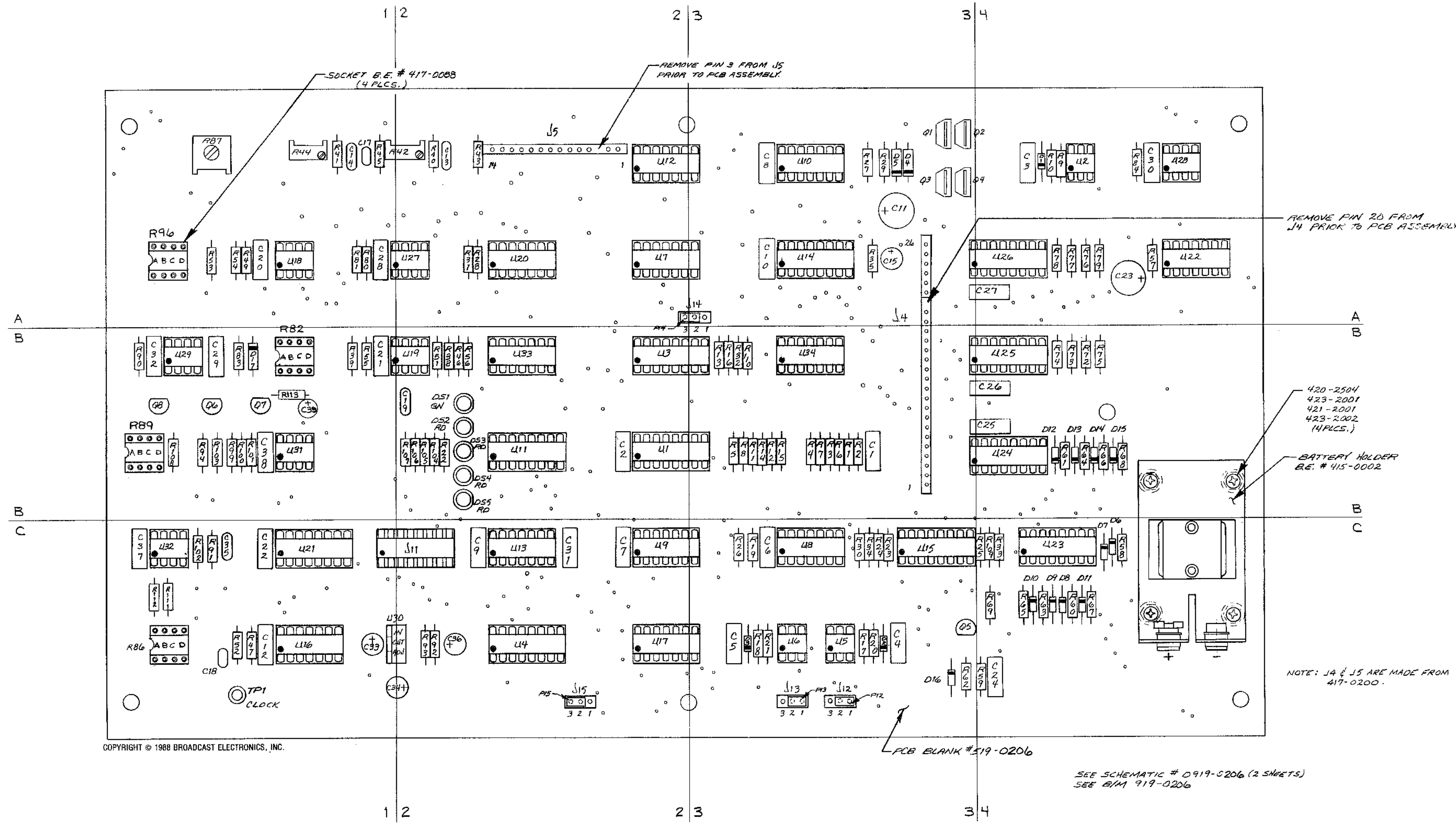
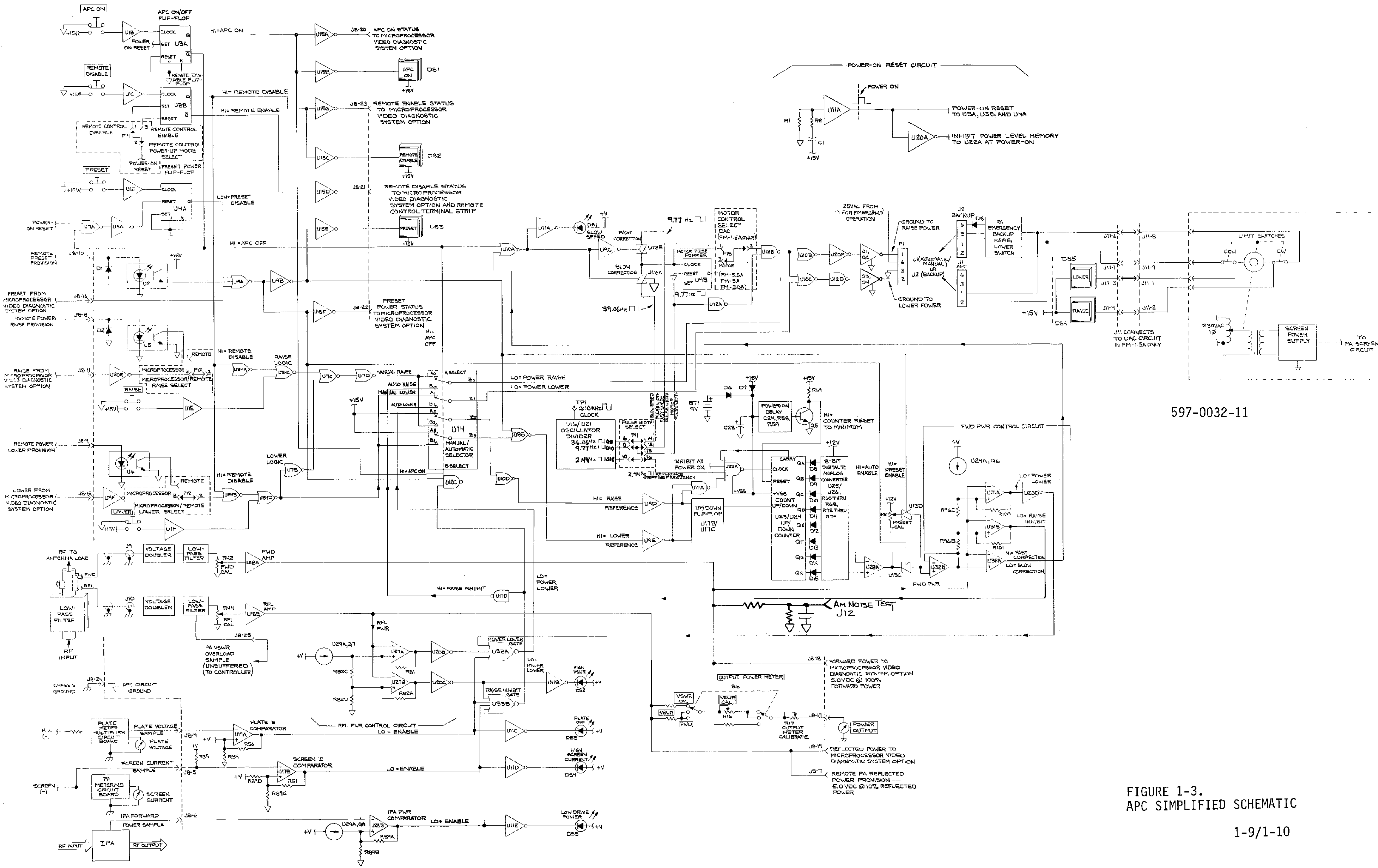
BROADCAST ELECTRONICS INC.
SCHEMATIC APC MAIN PCB
919-0206
REV. B
SHEET 2 OF 2



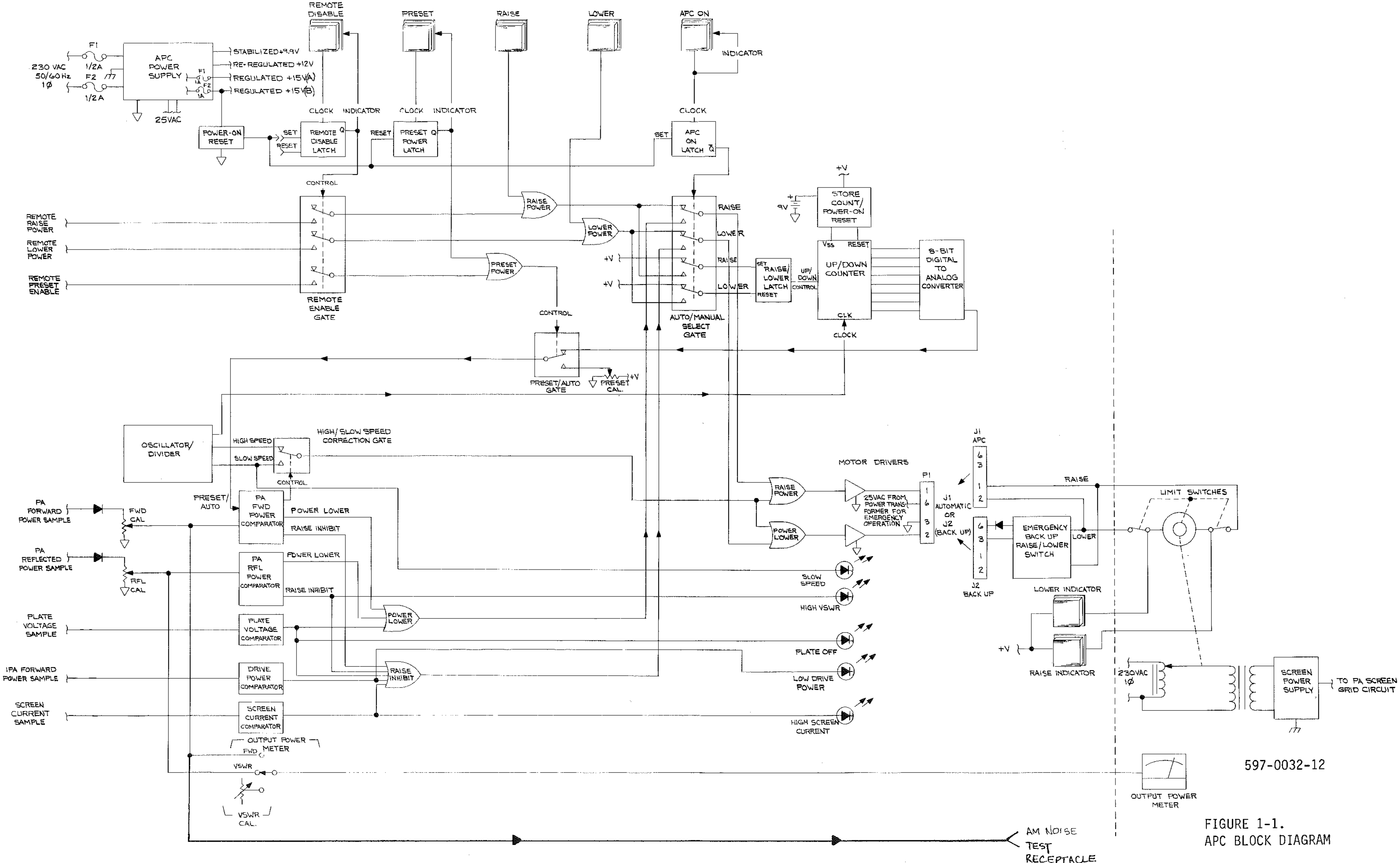
SEE SCHEMATIC # 0919-0206 (2 SHEETS)
SEE B/M 919-0206

TOLERANCE UNLESS OTHERWISE SPECIFIED DECIMAL 2 PL=.01 3PL=.005 FRACTIONAL ±1/64 ANGULAR ± 1° SHARP EDGES TO BEND RADII FILLET RADII	DRAWN BY JAH	DATE 1-19-88	BROADCAST ELECTRONICS INC.	
	CHECKED BY	DATE	TITLE PCB ASSEMBLY APC MAIN PCB	
	PROJECT ENGR. SMM	DATE 1-26-89		
	APPROVED BY		D DWG. NO. TYPE A 919-0206	REV. B
MATERIAL	TREATMENT OR FINISH		APC	SCALE 2/1 SHEET 1 OF 1



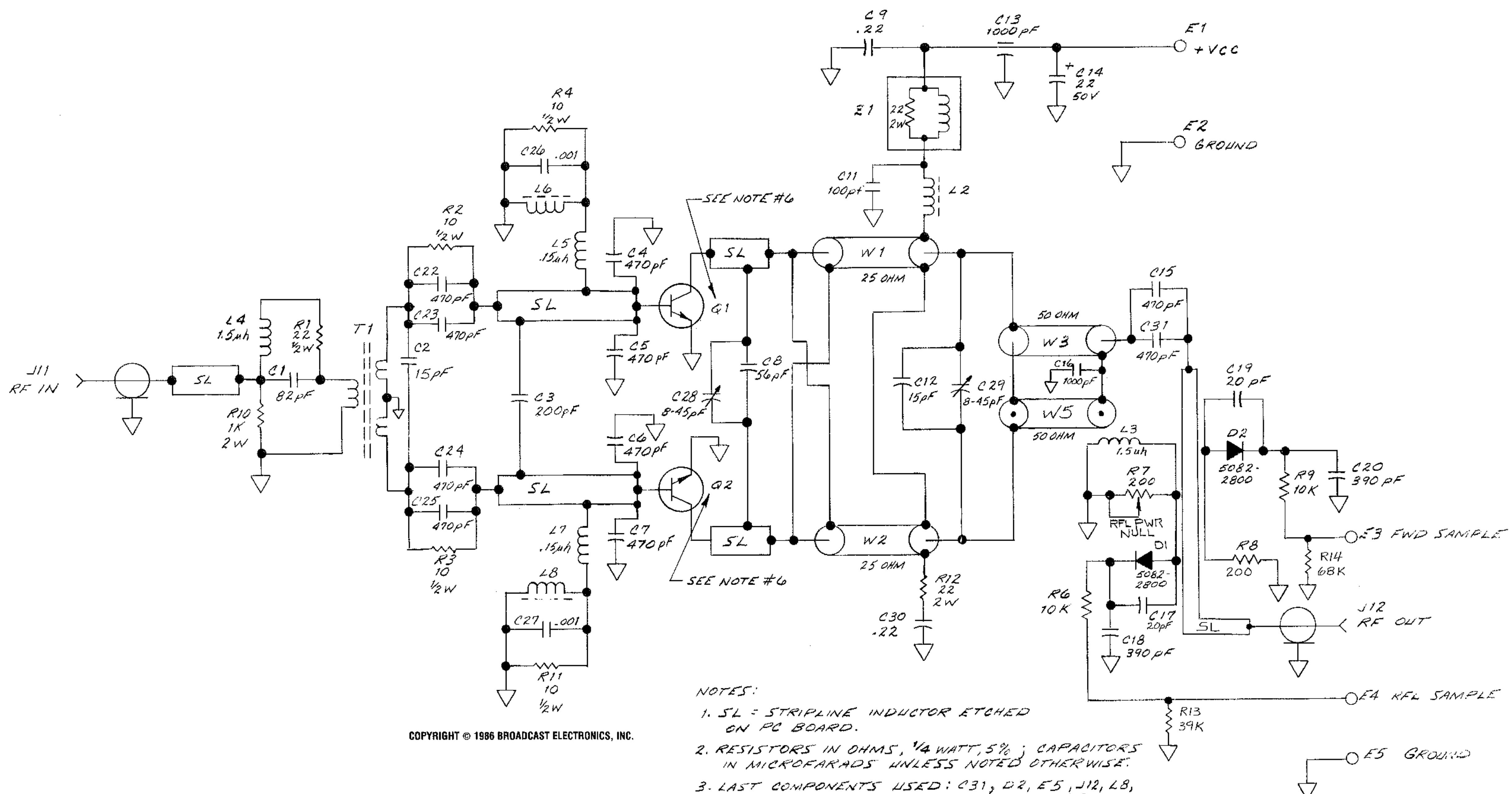
597-0032-11

FIGURE 1-3.
APC SIMPLIFIED SCHEMATIC



597-0032-12

FIGURE 1-1.
APC BLOCK DIAGRAM



NOTES:

1. SL = STRIPLINE INDUCTOR ETCHED ON PC BOARD.
2. RESISTORS IN OHMS, 1/4 WATT, 5%; CAPACITORS IN MICROFARADS UNLESS NOTED OTHERWISE.
3. LAST COMPONENTS USED: C31, D2, E5, J12, L8, Q2, T1, W5, R12, Z1
4. SEE PCB ASSY. # D959-0132, SHEET 1 OF 2.
5. COMPONENTS NOT USED: R5, C10, J1-J10
6. Q1 AND Q2 MATCHED PAIR OF B.E. PART NO. 210-1460-001. MUST HAVE SAME COLOR DOT.

TOLERANCE (DECIMAL) U.O.S.
.X ± .030 .XXX ± .005
.XX ± .015 ANGLES ± 1°

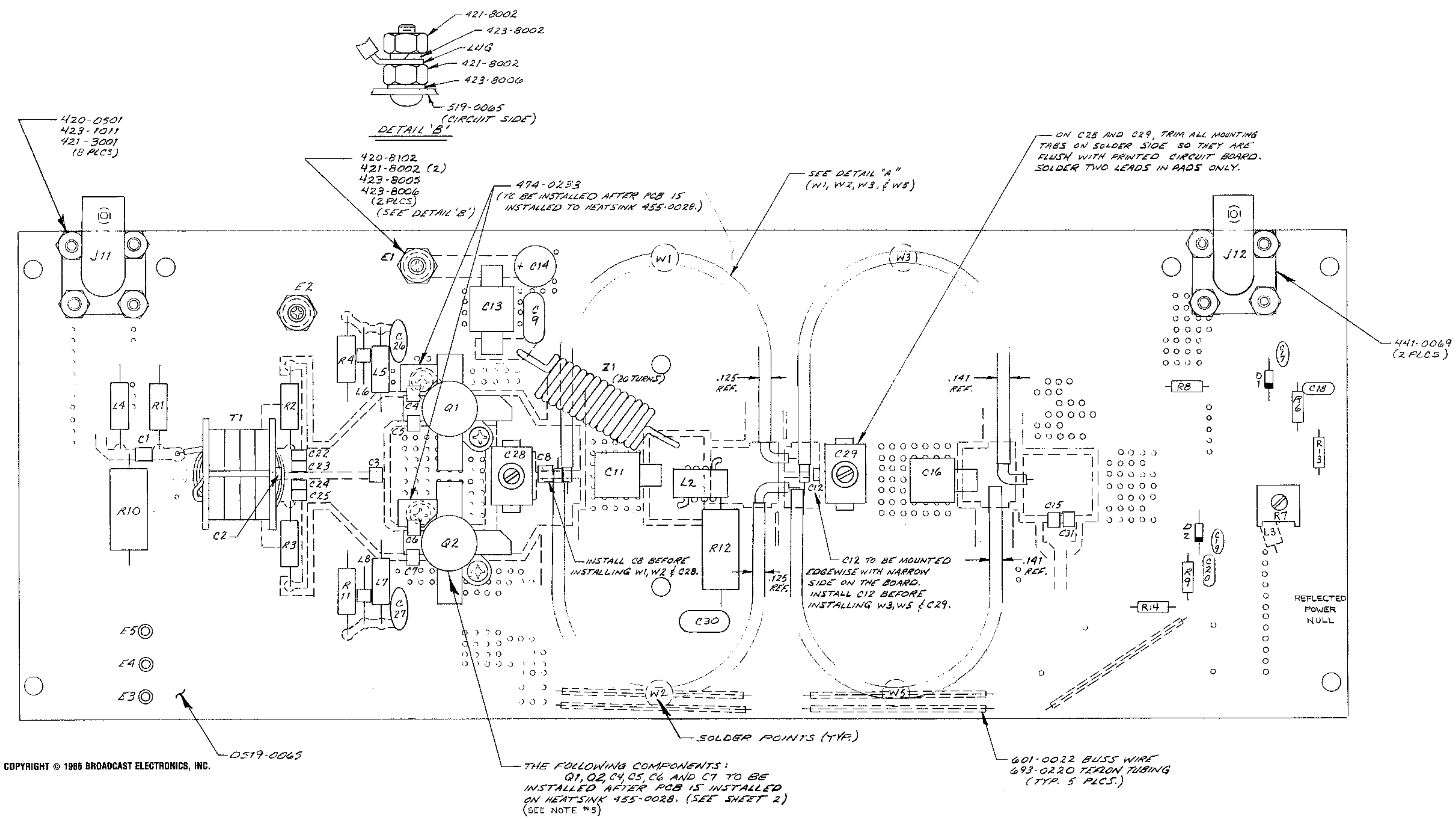
DWN. BY MERKEL 3-10-83	NEXT ASSY.	
CHKD.		
ME	PRODUCT USED ON IPA	
EE		
PROJ. ENGR. SS 5/16/83	FINISH	
DFTG. SUPVR. MH 5-13-83		
MFG.		

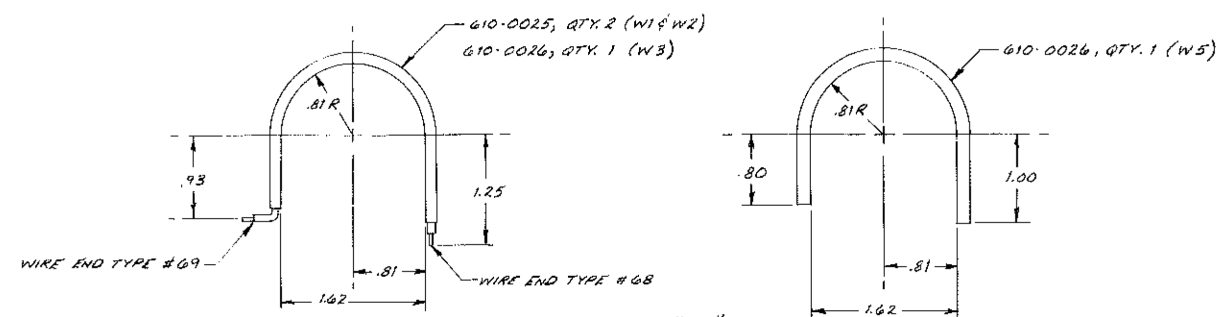
BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BCST ELECT QUI

TITLE PCB SCHEMATIC - IPA RF AMP PCB

SHEET 1 OF 1 | SCALE — | REV G

TYPE 5 | SIZE C | DWG. NO. 919-0065





DETAIL "A"
(SEE NOTE #1)

NOTES:
1. USE FIXTURE TO FORM W1, W2, W3, & W5.
2. REFERENCE SCHEMATIC #D959-0131
3. REFERENCE B/M 919-0065.
4. REFERENCE RF AMP PCB SCHEMATIC #C919-0065.
5. TRANSISTORS Q1 & Q2 ARE MATCHED PAIRS.

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL

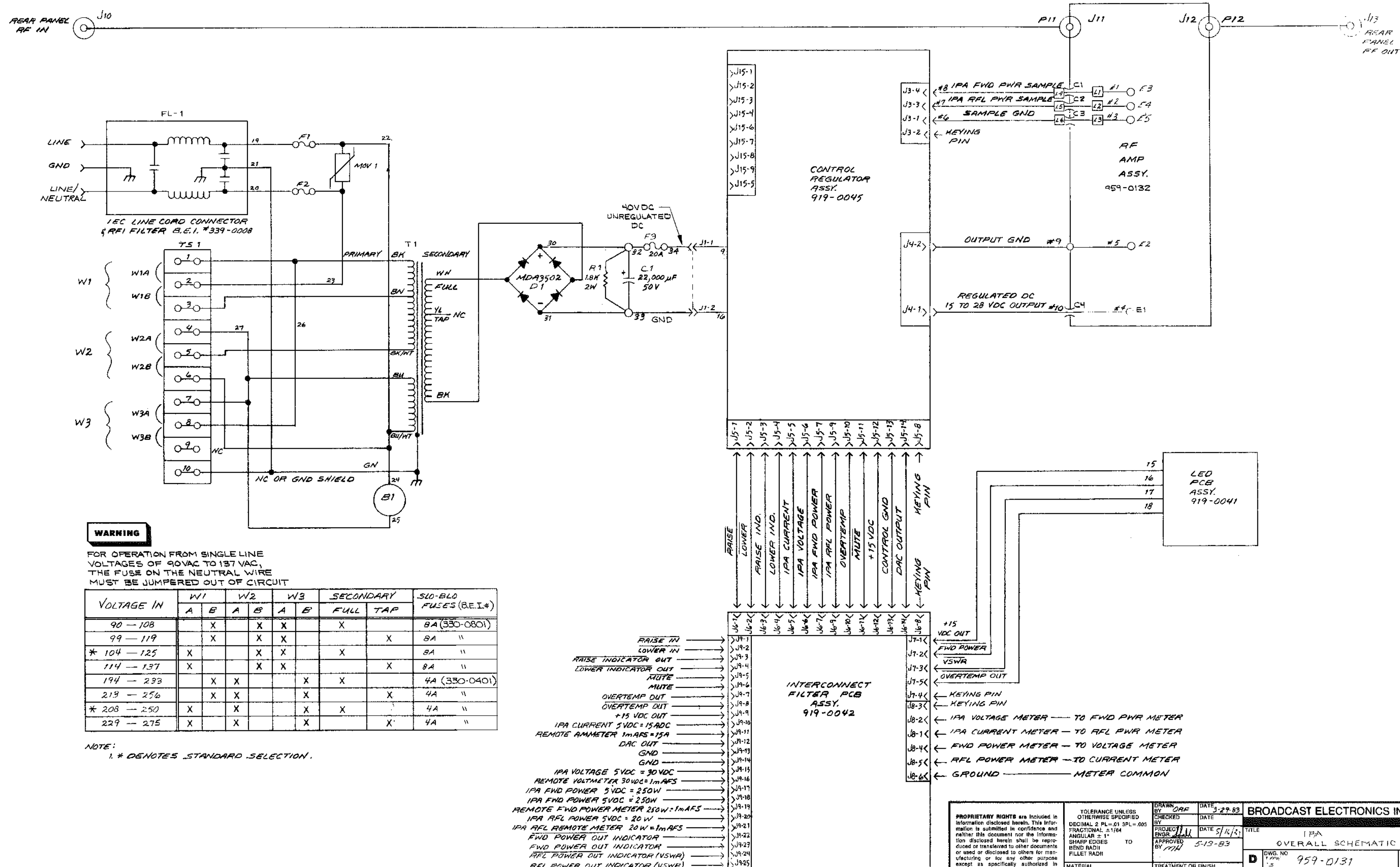
DRAWN BY DAF	DATE 8-12-88
CHECKED BY	DATE
PROJECT ENGR.	DATE 9-14-88
APPROVED BY	
TREATMENT OR FINISH	

BROADCAST ELECTRONICS INC.

TITLE IPA RF AMP ASSEMBLY

D | DWG. NO. TYPE A | 959-0132 | REV. M

IPA | SCALE 2/1 | SHEET 1 OF 2



WARNING

FOR OPERATION FROM SINGLE LINE VOLTAGES OF 90VAC TO 137 VAC, THE FUSE ON THE NEUTRAL WIRE MUST BE JUMPERED OUT OF CIRCUIT

VOLTAGE IN	W1		W2		W3		SECONDARY		SLO-BLO FUSES (B.E.I.#)
	A	B	A	B	A	B	FULL	TAP	
90 — 108		X		X	X		X		8A (330-0801)
99 — 119		X		X	X			X	8A "
* 104 — 125	X			X	X		X		8A "
114 — 137	X			X	X			X	8A "
194 — 233		X	X			X	X		4A (330-0401)
213 — 256		X	X			X		X	4A "
* 208 — 250	X		X			X	X		4A "
229 — 275	X		X			X		X	4A "

NOTE:

1. * DENOTES STANDARD SELECTION.

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL

DRAWN BY DRF DATE 3-29-83
CHECKED BY DATE
PROJECT ENGR. DATE 5/16/83
APPROVED BY MH 5-13-83
TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.

TITLE IPA OVERALL SCHEMATIC

D DWG. NO 959-0131 REV G

IPA SCALE NTS SHEET 1 OF 1

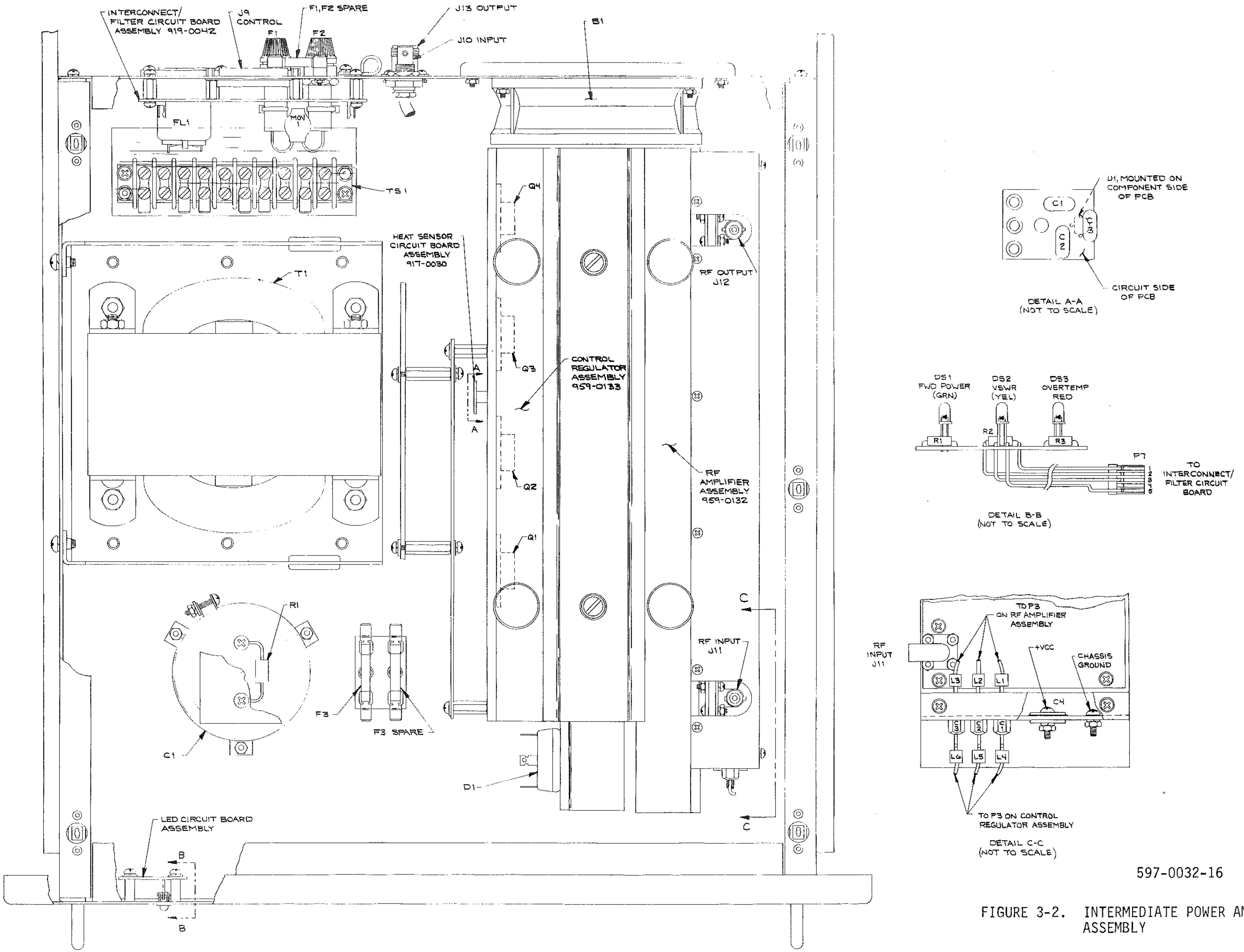
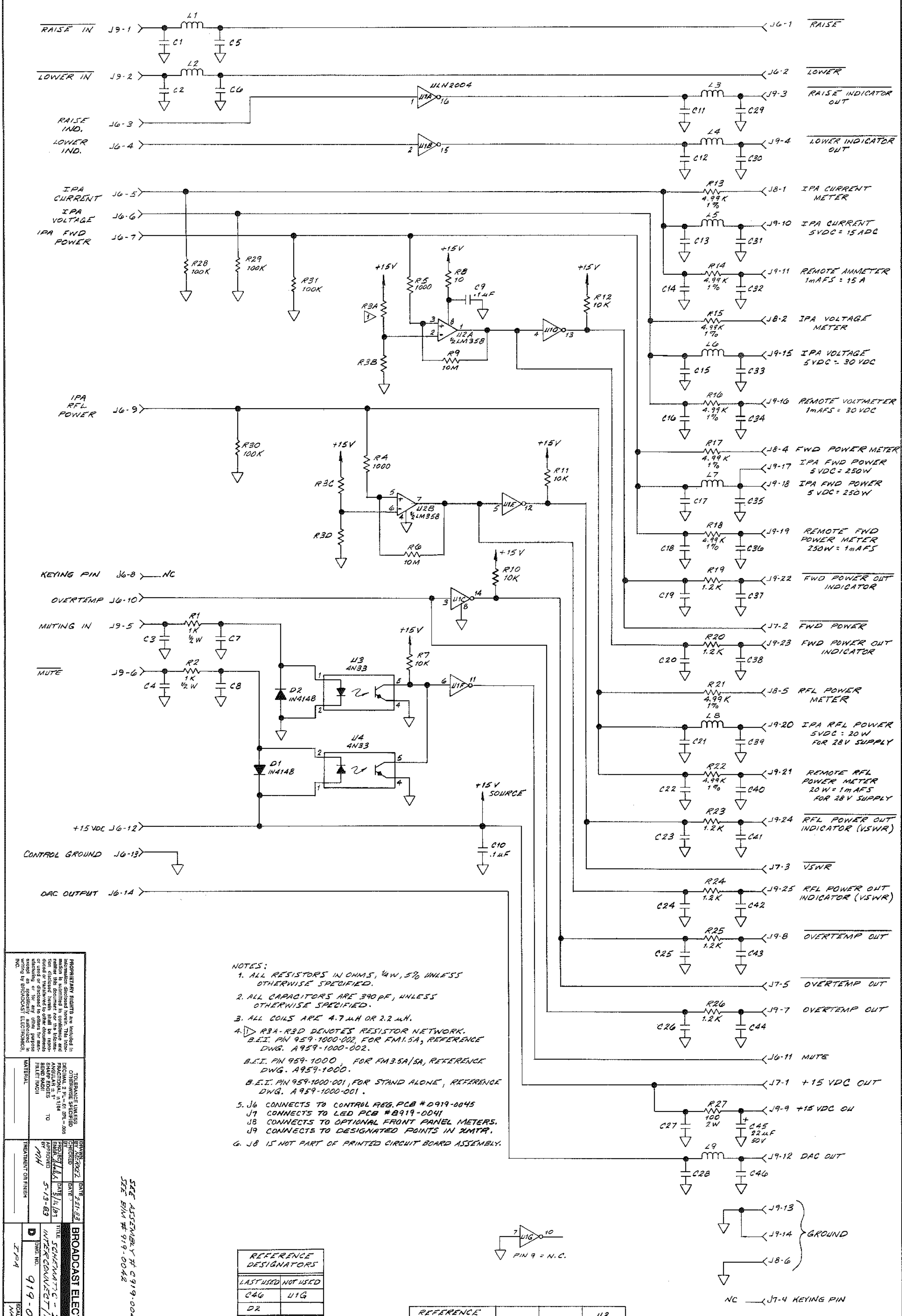


FIGURE 3-2. INTERMEDIATE POWER AMPLIFIER ASSEMBLY



NOTES:

1. ALL RESISTORS IN OHMS, ¼W, 5% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE 390pF, UNLESS OTHERWISE SPECIFIED.
3. ALL COILS ARE 4.7 µH OR 2.2 µH.
4. R3A-R3D DENOTES RESISTOR NETWORK.
   B.E.I. P/N 959-1000-002, FOR FM1.5A, REFERENCE DWG. A959-1000-002.
   B.E.I. P/N 959-1000, FOR FM3.5A/5A, REFERENCE DWG. A959-1000.
   B.E.I. P/N 959-1000-001, FOR STAND ALONE, REFERENCE DWG. A959-1000-001.
5. J6 CONNECTS TO CONTROL REG. PCB #D919-0045
   J7 CONNECTS TO LED PCB #B919-0041
   J8 CONNECTS TO OPTIONAL FRONT PANEL METERS.
   J9 CONNECTS TO DESIGNATED POINTS IN XMTR.
6. J8 IS NOT PART OF PRINTED CIRCUIT BOARD ASSEMBLY.

SEE ASSEMBLY # C919-0042
SEE B/M # 919-0042

REFERENCE DESIGNATORS	
LAST USED	NOT USED
C46	U1G
D2	
J9	
L9	
R31	
U4	

REFERENCE DESIGNATORS	U1	U2	U3, U4
B.E. PART NO.	226-2004	221-0358	229-0033
VENDOR PART NO.	ULN2004	LM358	4N33
VOLTAGE PIN NO.	——	8	——
GROUND PIN NO.	8	4	——

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL

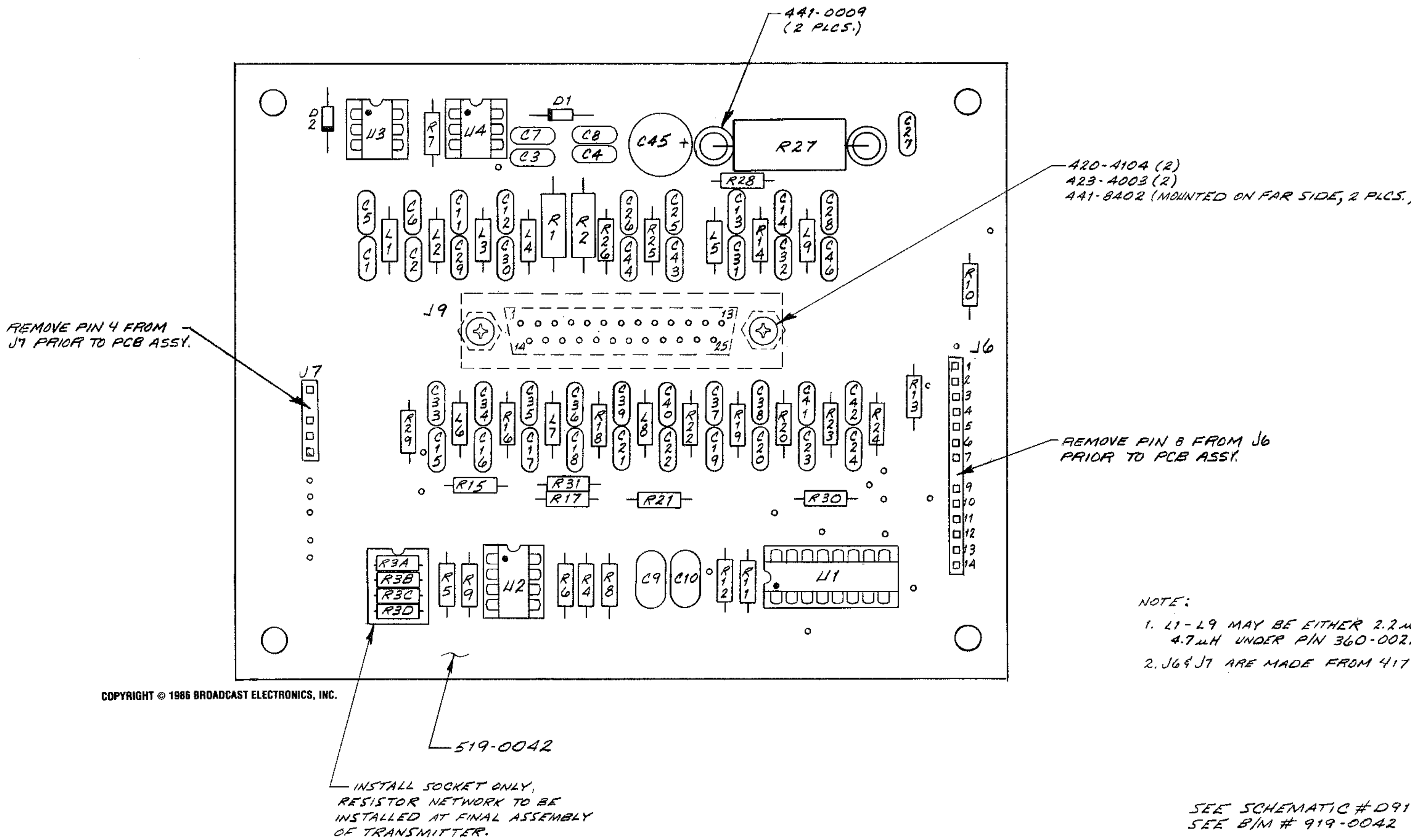
DRAWN BY MERKEL DATE 2-21-83
CHECKED BY DATE
PROJECT ENGR. DATE 5/16/83
APPROVED BY MH 5-13-83
TREATMENT OR FINISH

BROADCAST ELECTRONICS INC.

TITLE SCHEMATIC - IPA INTERCONNECT/FILTER PCB

D DWG. NO. 919-0042 REV. D

IPA SCALE NA SHEET 1 OF 1



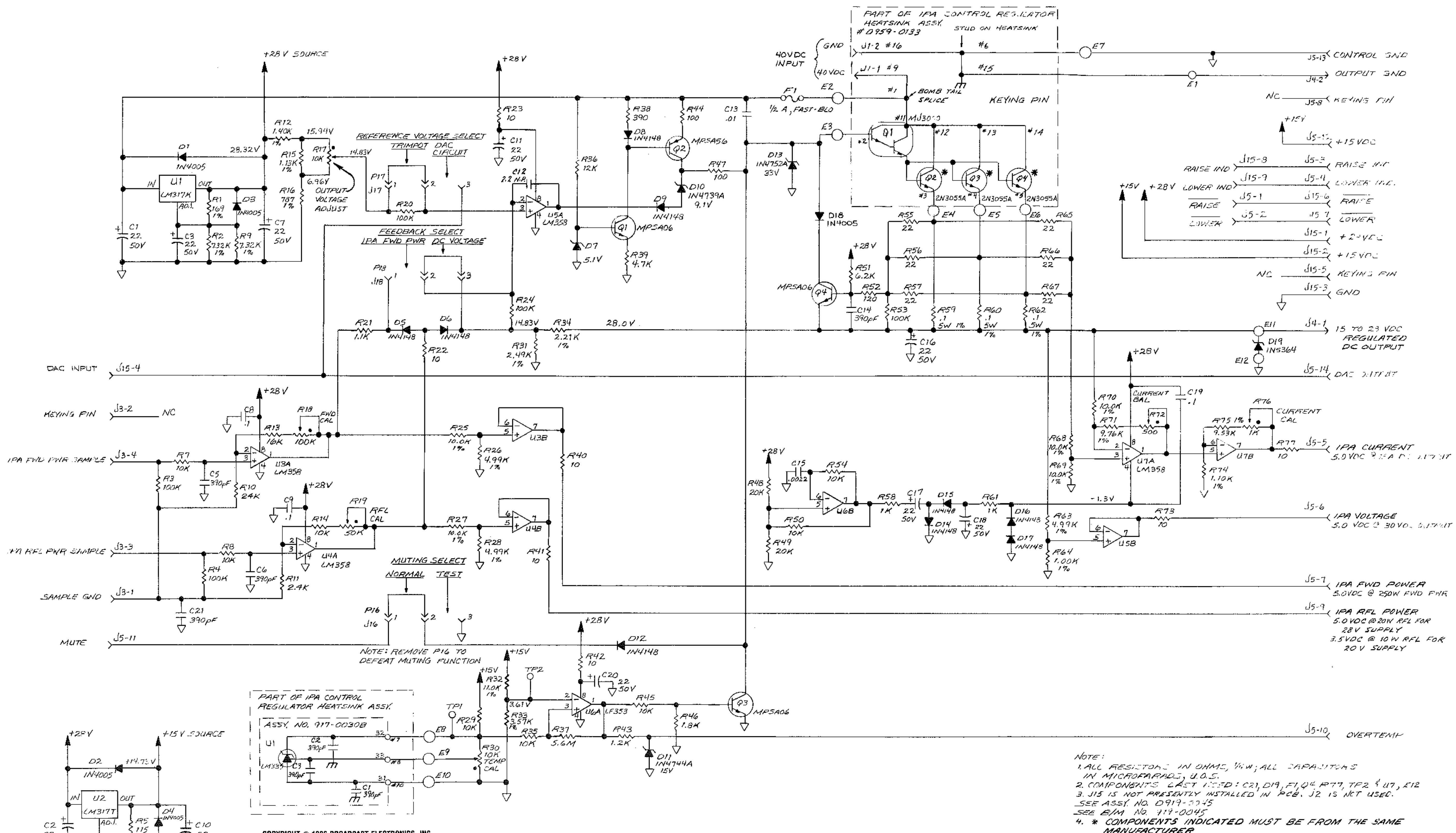
NOTE:

1. L1-L9 MAY BE EITHER 2.2μH OR 4.7μH UNDER P/N 360-0022.
2. J6 & J7 ARE MADE FROM 417-0200.

SEE SCHEMATIC # D919-0042
SEE B/M # 919-0042

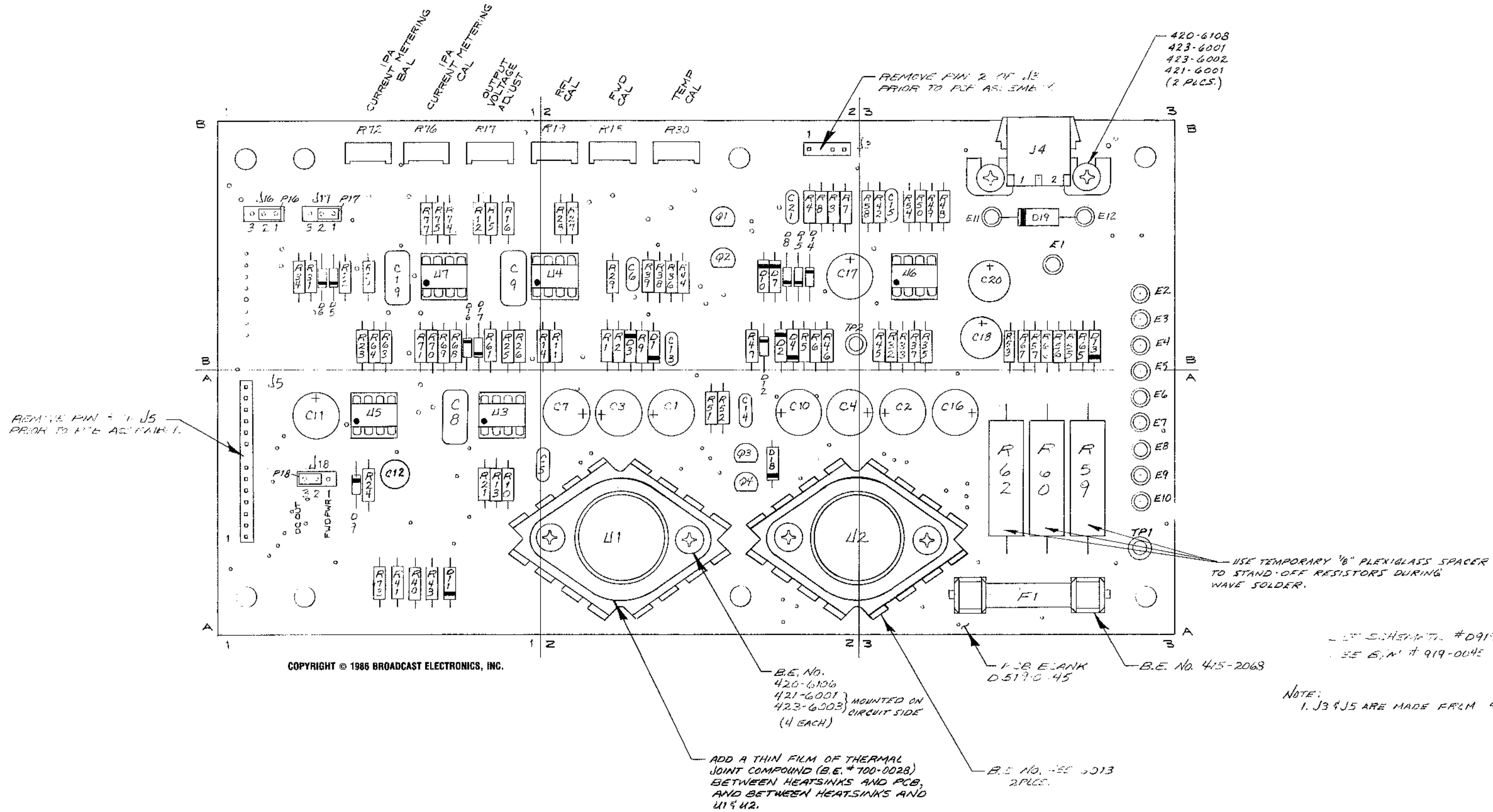
TOLERANCE (DECIMAL) U.O.S.
.X ± .030 .XXX ± .005
.XX ± .015 ANGLES ± 1°

DWN. BY MERKEL 2-26-83	NEXT ASSY.	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST. QUINCY, IL 62305 217/224-9600 TELEX 250142 CABLE BCST ELECT QUI
CHKD.		
ME	PRODUCT USED ON IPA	TITLE PCB ASSEMBLY - IPA INTERCONNECT/ FILTER BOARD
EE		SHEET 1 OF 1
PROJ. ENGR. S.S. 5/6/83	FINISH	SCALE 2/1 · REV D
DFTG. SUPVR. 5-13-83 MH		TYPE A · SIZE C · DWG. NO. 919-0042
MFG.		



NOTE:
1. ALL RESISTORS IN OHMS, 1/4W; ALL CAPACITORS IN MICROFARADS, U.O.S.
2. COMPONENTS LAST USED: C21, D19, F1, Q4, R77, TP2 & U7, E12
3. J15 IS NOT PRESENTLY INSTALLED IN PCB. J2 IS NOT USED.
SEE ASSY. NO. D919-0045
SEE B/M NO. 919-0045
4. * COMPONENTS INDICATED MUST BE FROM THE SAME MANUFACTURER

TOLERANCE UNLESS OTHERWISE SPECIFIED DECIMAL 2 PL=.01 3PL=.005 FRACTIONAL ±1/64 ANGULAR ± 1° SHARP EDGES TO BEND RADII FILLET RADII	DRAWN BY ORF	DATE 2-23-83	BROADCAST ELECTRONICS INC.	
	CHECKED BY	DATE	TITLE SCHEMATIC IPA CONTROL REGULATOR PCB	
	PROJECT ENGR.	DATE 5/13/83		
	APPROVED BY MH	5-13-83	D DWG. NO. 919-0045	REV. G
MATERIAL	TREATMENT OR FINISH		SCALE NTS	SHEET 1 OF 1



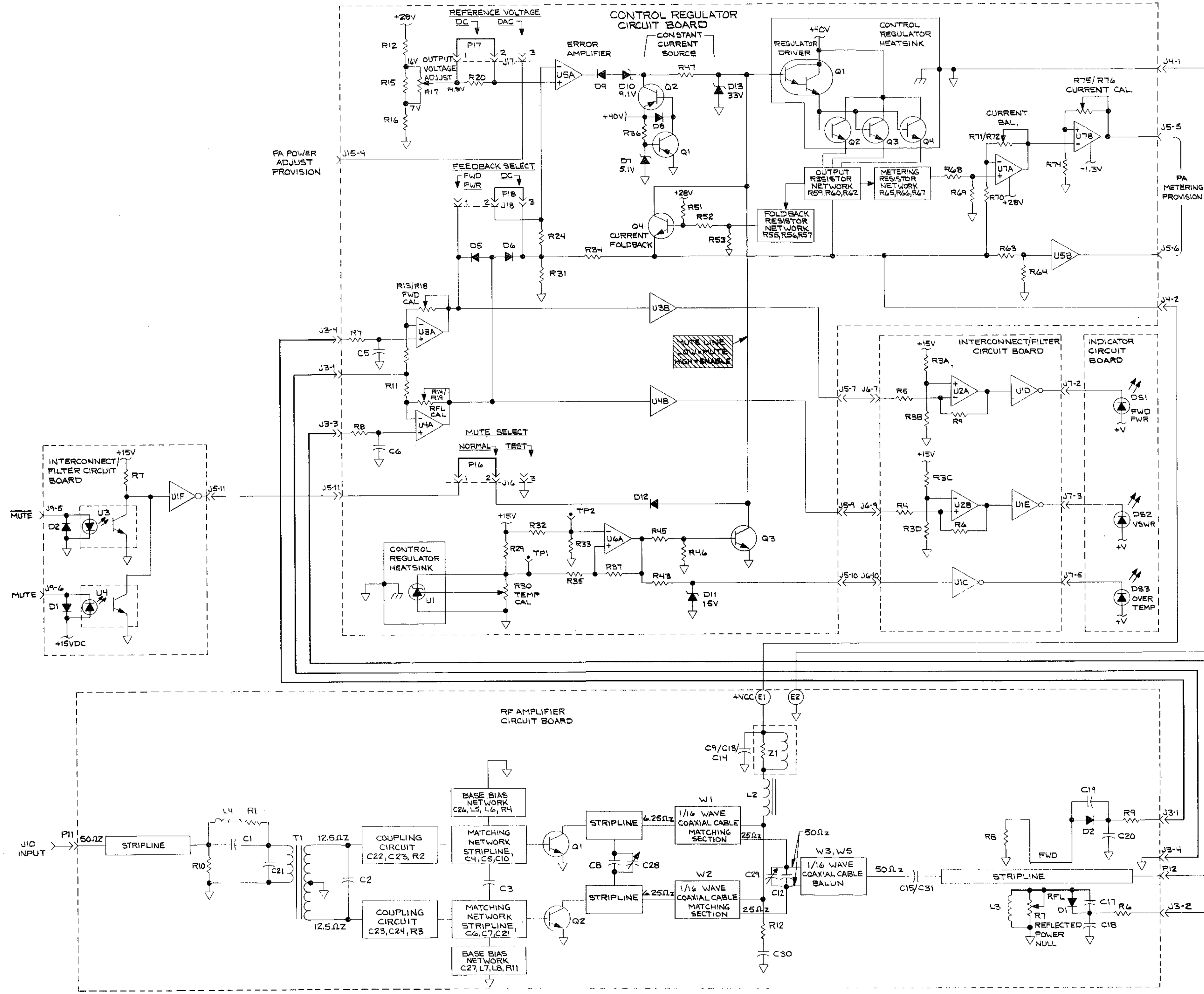
SEE SCHEMATIC #0919-0045
SEE B/M # 919-0045

NOTE:
1. J3 & J5 ARE MADE FROM 417-0200.

TOLERANCE UNLESS OTHERWISE SPECIFIED
DECIMAL 2 PL=.01 3PL=.005
FRACTIONAL ±1/64
ANGULAR ± 1°
SHARP EDGES TO
BEND RADII
FILLET RADII

MATERIAL

DRAWN BY OHF	DATE 3-7-83	BROADCAST ELECTRONICS INC.
CHECKED BY	DATE	TITLE PCB ASSEMBLY IPA CONTROL REGULATOR PCB
PROJECT ENGR.	DATE 5/11/83	D DWG. NO. TYPE A 919-0045 REV. F
APPROVED BY MH	5-13-83	SCALE 2/1 SHEET 1 OF 1
TREATMENT OR FINISH		



597-0032-22

FIGURE 1-3.
IPA SIMPLIFIED SCHEMATIC

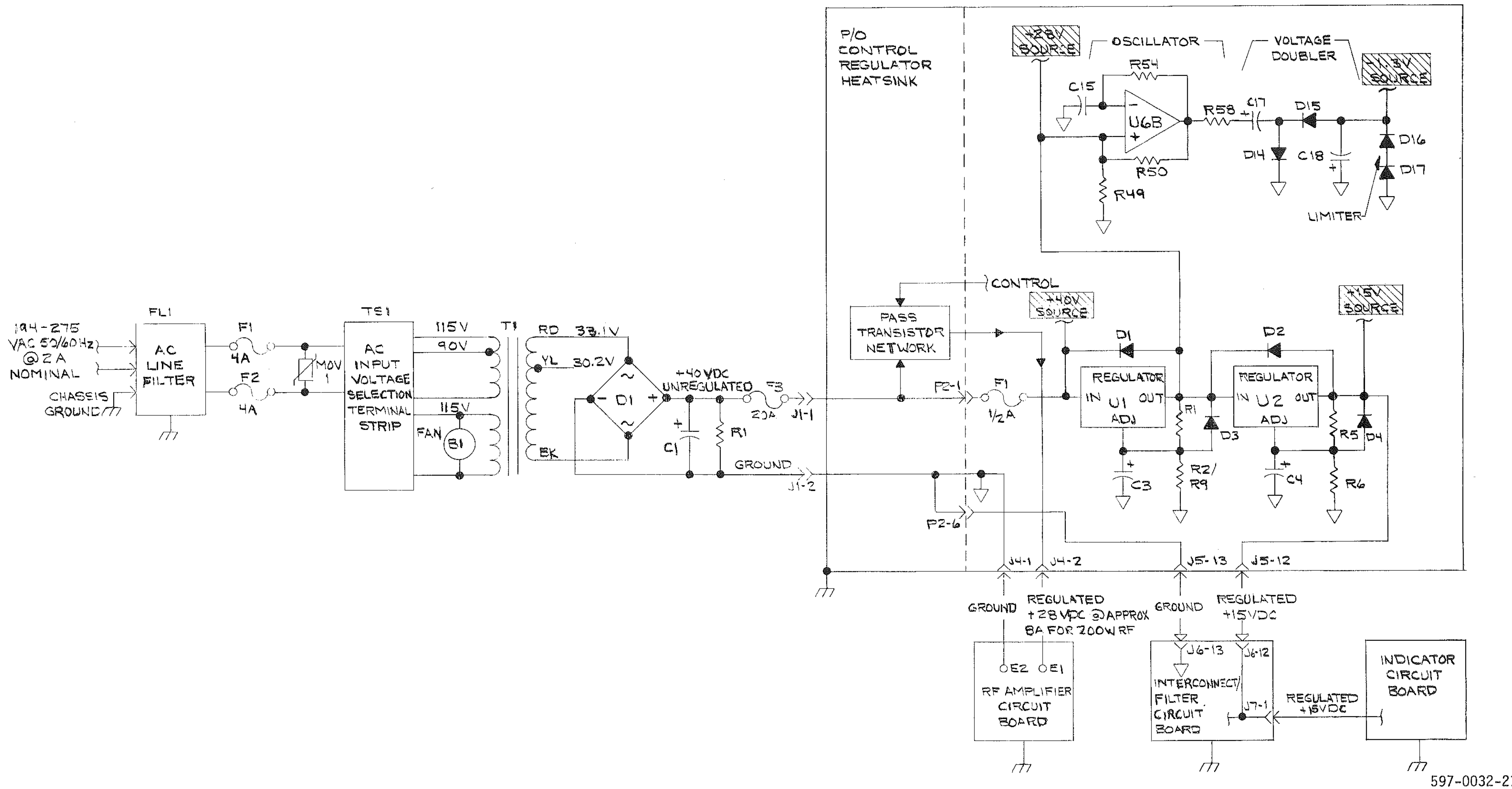
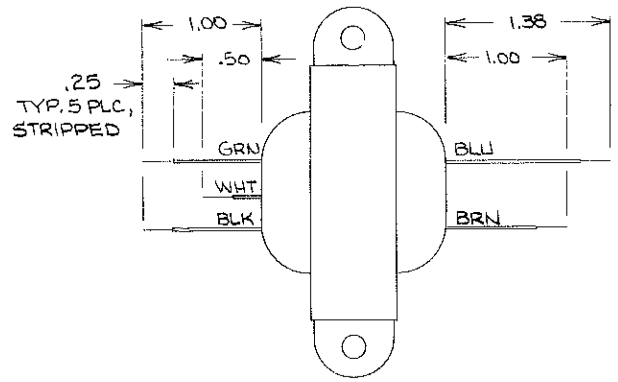
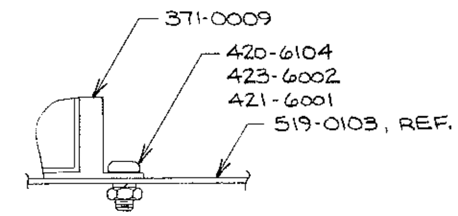
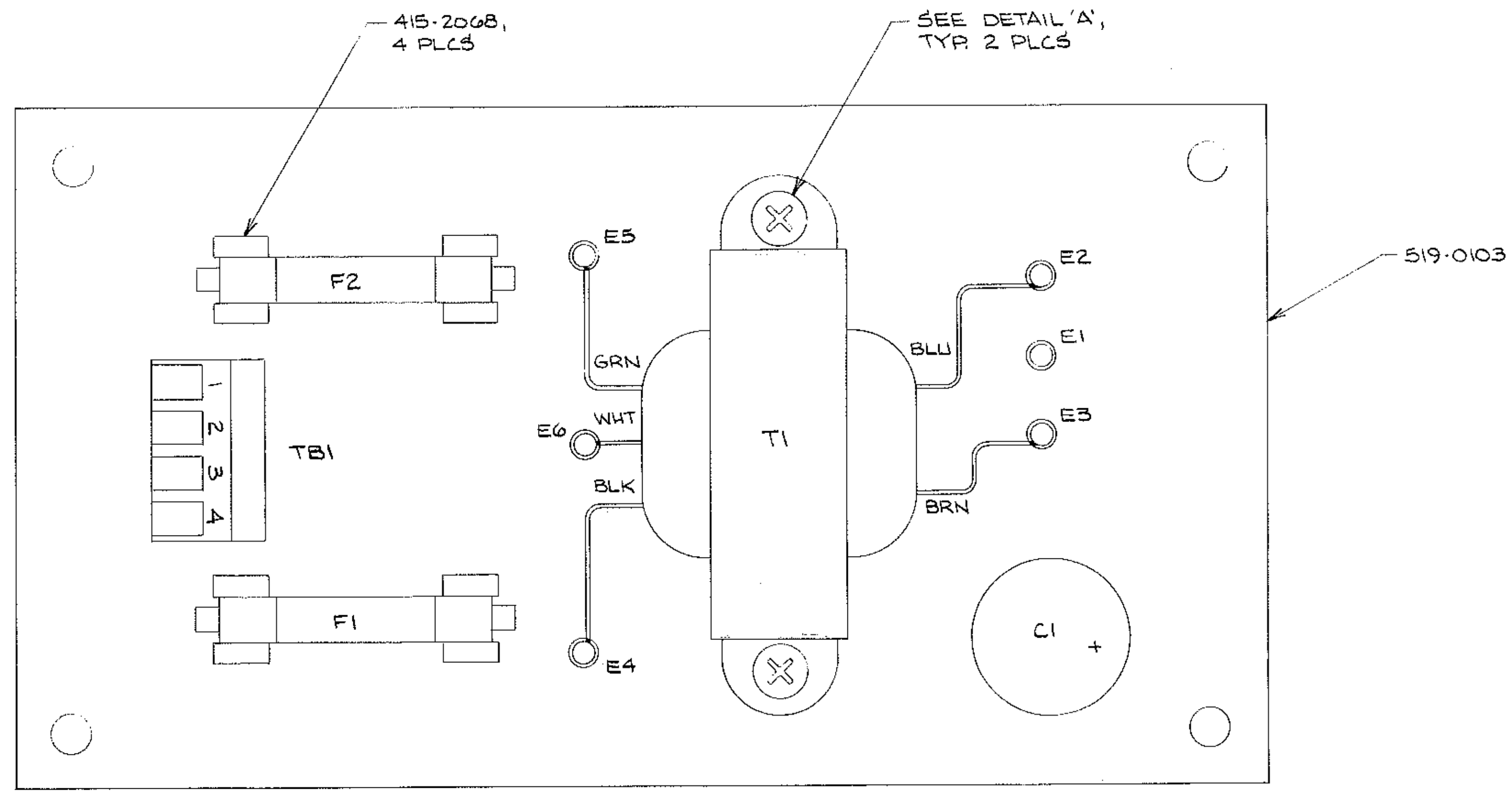


FIGURE 1-2. IPA POWER DISTRIBUTION



DETAIL 'A'





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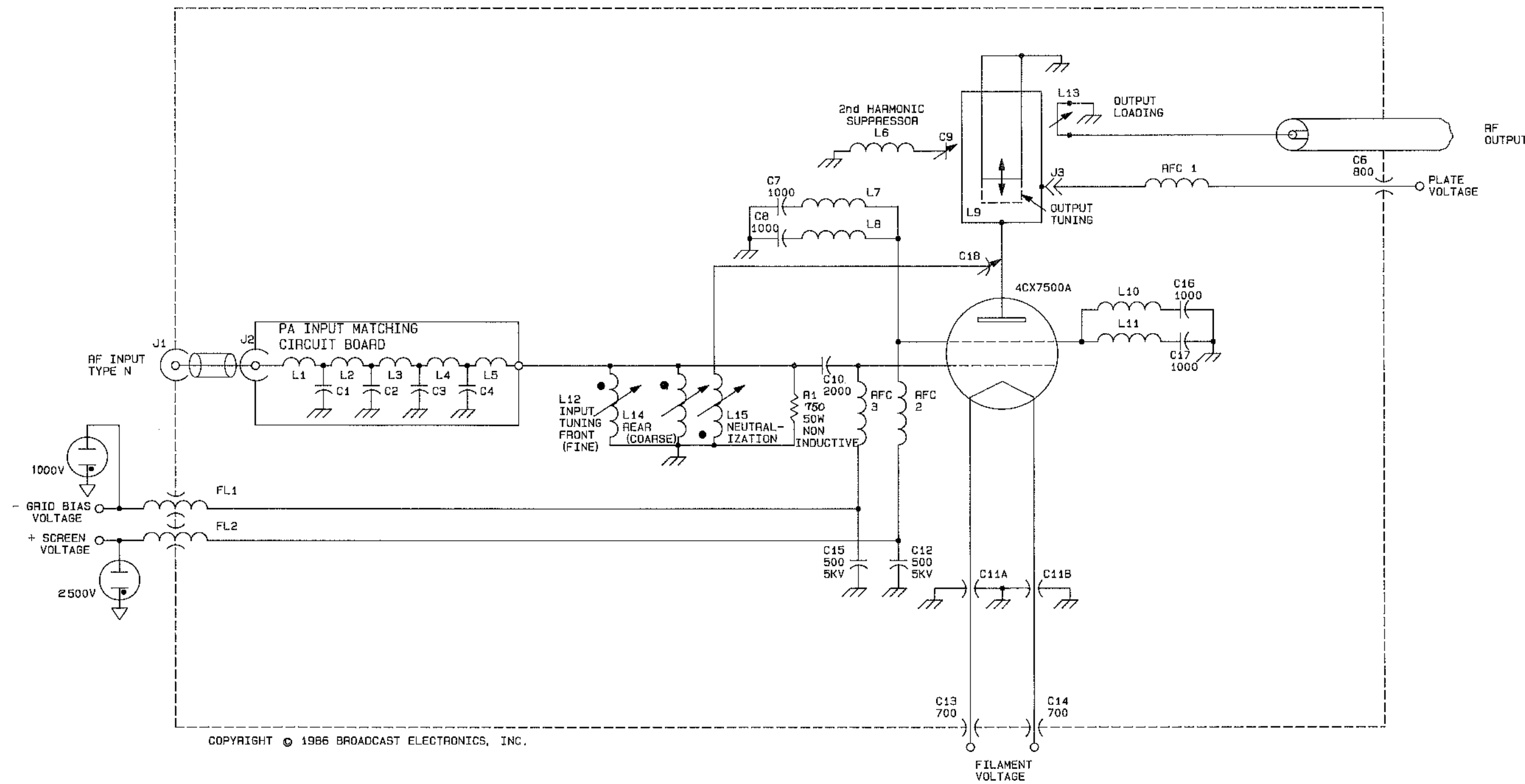
TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY MSE 1-30-87	MATERIAL SEE B/M 919-0103	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600 TELEX 250142 CABLE BROADCAST	
CHKD			
ME	FINISH	TITLE PCB ASSEMBLY HUM NULL	
PROJ. ENGR. 2/1/87		TYPE A · SIZE C · DWG. NO. 919-0103	REV A
MFG.	NEXT ASSY.	MODEL FM10A · SCALE 2/1	SHEET 1 OF 1



NOTES:
1. ALL CAPACITORS IN pF; ALL RESISTORS IN OHMS, UNLESS OTHERWISE SPECIFIED.
2. COPPER-CLAD FILM CAPACITORS: C6-C8, C10, C11, C13, C14, C16 & C17.
3. C11 IS PART OF TUBE SOCKET.
4. COMPONENTS LAST USED: C18, E2, FL2, J3, L15, R1, RFC3 & V1.

TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY JAH 8-22-86
CHKD
ME
PROJ. ENGR.
MFG.

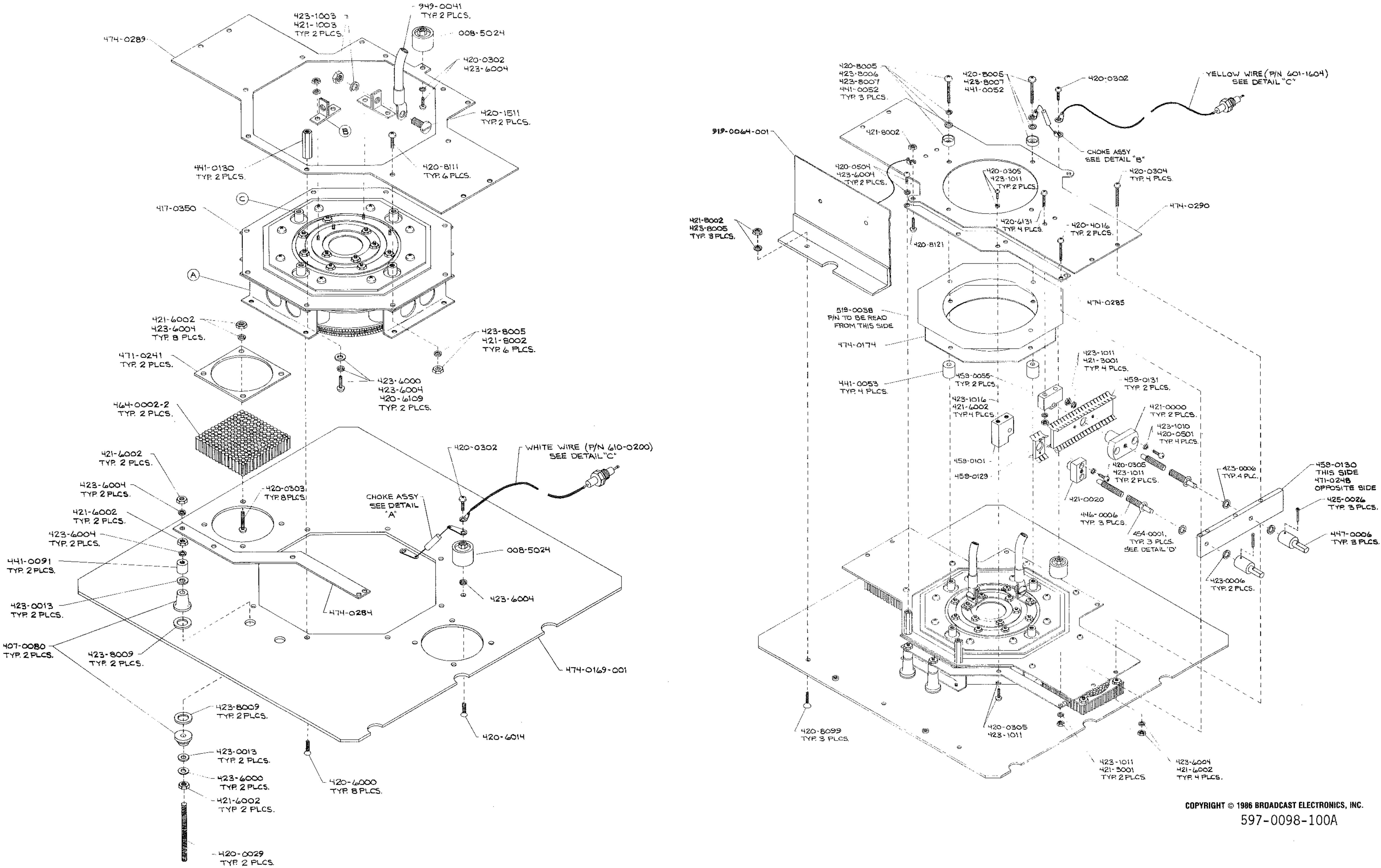
MATERIAL —
FINISH —
NEXT ASSY.

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE SCHEMATIC PA RF ENCLOSURE

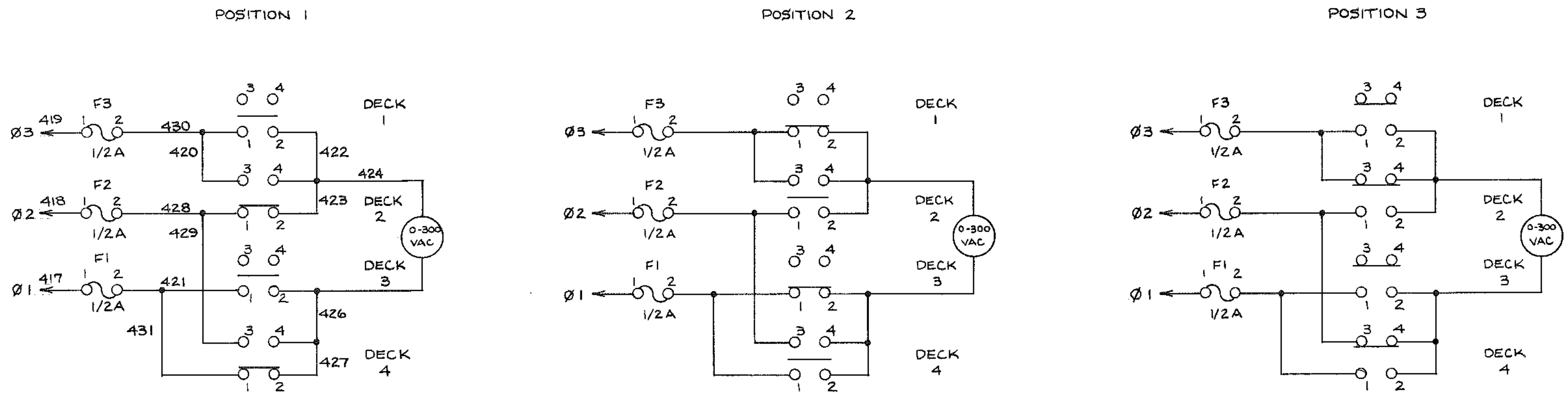
TYPE S | SIZE C | DWG. NO. 959-0230 | REV

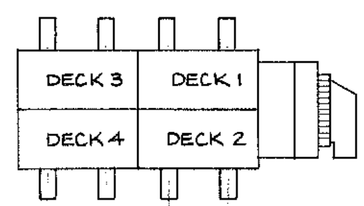
MODEL FM-10A | SCALE — | SHEET 1 OF 1



597-0098-100A

FIGURE 7-12. ASSEMBLY DIAGRAM, PA INPUT CIRCUIT
(Sheet 1 of 2)





SIDE VIEW OF SWITCH SHOWING LOCATION OF DECKS.

POSITION	METERING
1	Ø1 — Ø2
2	Ø1 — Ø3
3	Ø2 — Ø3

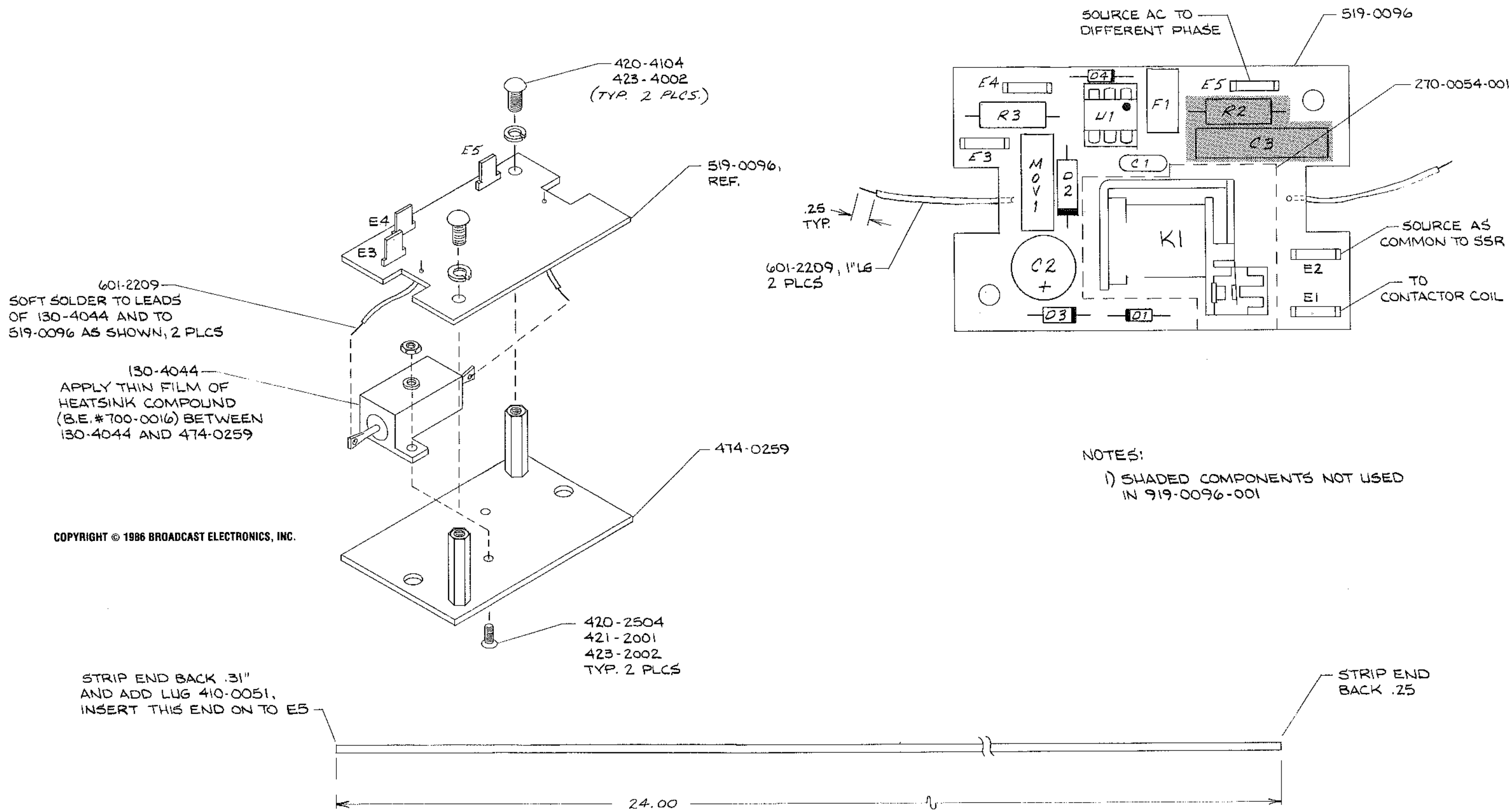
TOLERANCE (DECIMAL) U.O.S.
.X ± .030 .XXX ± .005
.XX ± .015 ANGLES ± 1°

DWN. BY MSE 4-4-84
CHKD. mH 4-5-84
ME
EE
PROJ. ENGR.
DFTG. SUPVR.
MFG.

NEXT ASSY.
PRODUCT USED ON FM5A/FM30A
FINISH

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BCST ELECT QUI

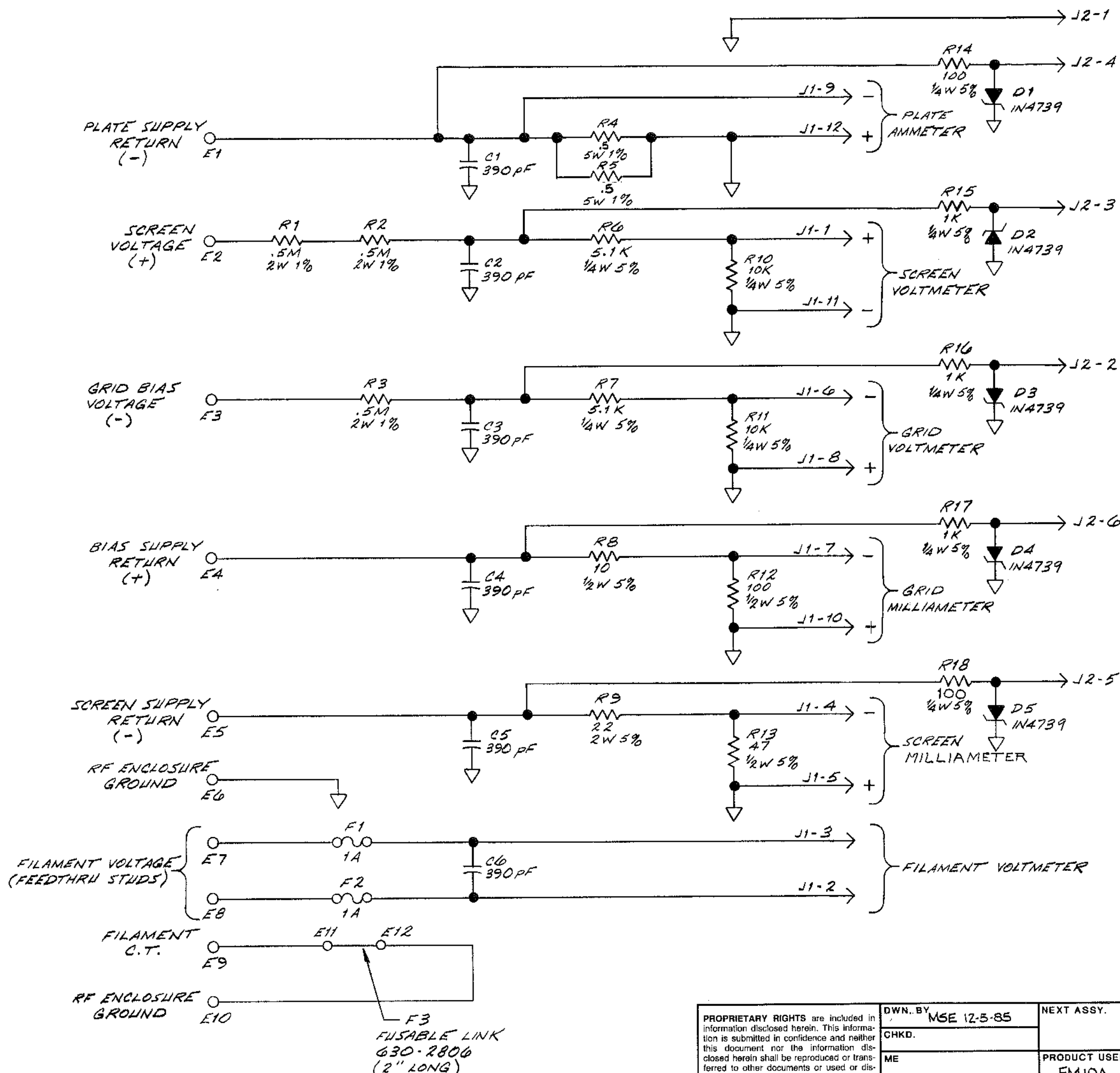
TITLE SCHEMATIC THREE PHASE AC VOLTMETER OPTION
SHEET 1 OF 1
SCALE ~ REV
TYPE S SIZE C DWG. NO. 909-0098



NOTES:
1) SHADED COMPONENTS NOT USED IN 919-0096-001

TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .015 ANGLES ± 1°

DWN. BY MSE 7-11-86	MATERIAL SEE B/M 919-0096	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST., P.O.BOX 3606 QUINCY, IL 62305 217/224-9600 TELEX 250142 CABLE BROADCAST
CHKD		
ME 7/14/86	FINISH	TITLE ASM, SOLID STATE RELAY REPLACEMENT + PCB
PROJ. ENGR. J Tucker 7-14-86		TYPE A SIZE C DWG. NO. 919-0096 919-0096-001 REV F
MFG.	NEXT ASSY.	MODEL XMTRS SCALE ~ SHEET 1 OF 1



NOTES:

1. ALL RESISTORS IN OHMS.
2. LAST COMPONENTS USED: C6, E12, F2, J2, R18, D5.
3. SEE ASSEMBLY #C919-0062-002
   SEE BIM # 919-0062-002
4. J2 TO TRANSMITTER CONTROLLER J2.
5. J1 TO METER PANEL.
6. J2-1, J2-5 ALSO TO APC.

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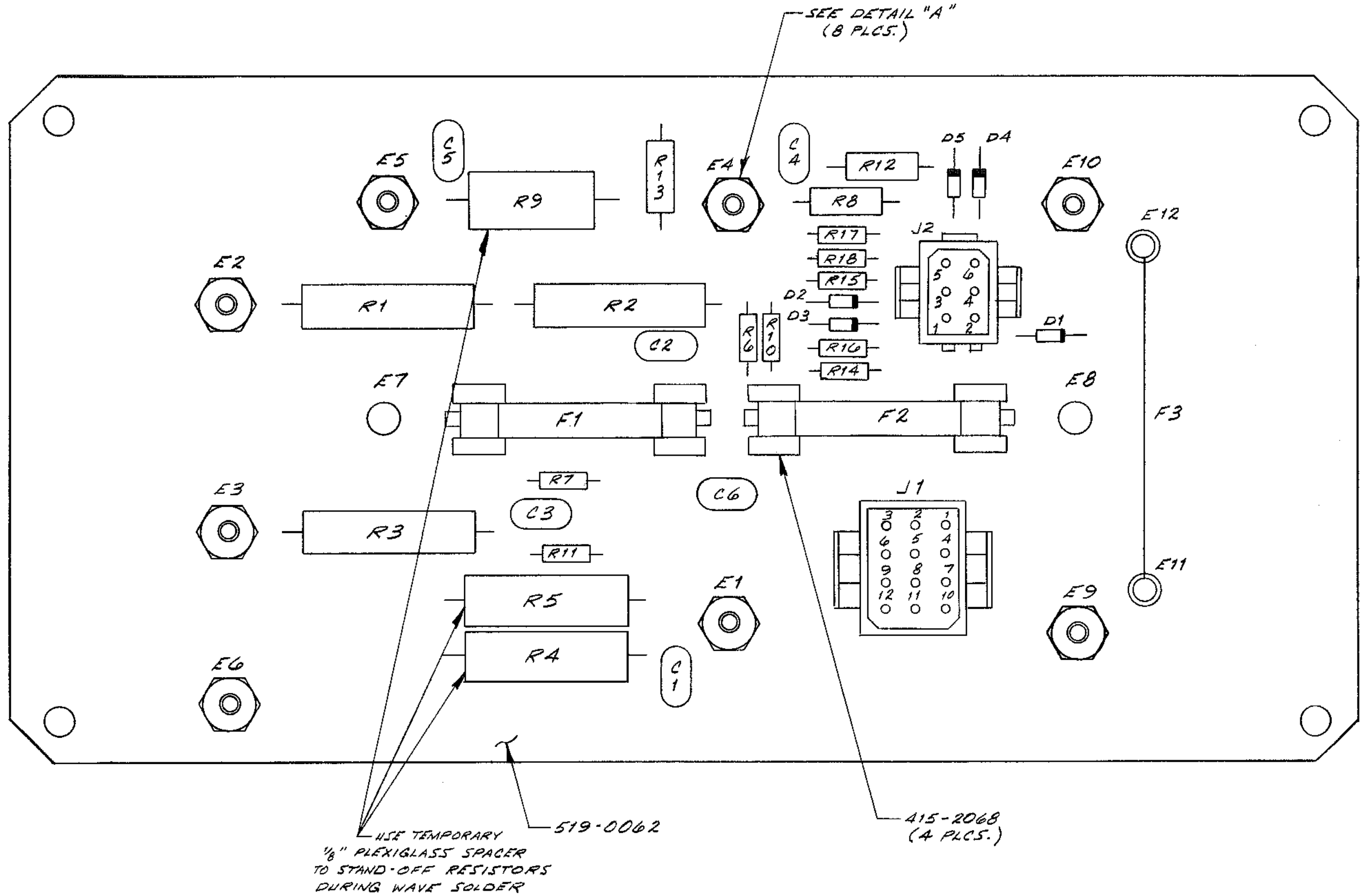
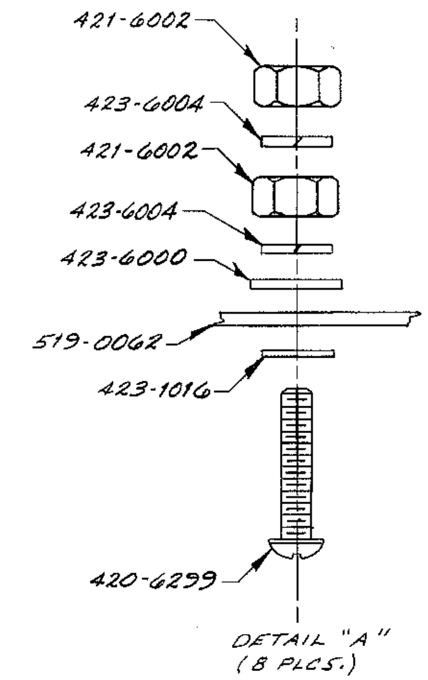
	CHKD.		
	ME	PRODUCT USED ON FM10A	TITLE SCHEMATIC - P.A. METERING PCB
	EE		SHEET 1 OF 1
	PROJ. ENGR. WJH/DBM	FINISH	SCALE —
TOLERANCE (DECIMAL) U.O.S. .X ± .030 .XXX ± .005 .XX ± .015 ANGLES ± 1°	DFTG. SUPVR.		REV A
	MFG.		TYPE S SIZE C DWG. NO. 919-0062-002





SEE SCHEMATIC # C 919-0062-002
SEE B/M # 919-0062-002

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TOLERANCE (DECIMAL) U.O.S.
.X ± .030 .XXX ± .005
.XX ± .015 ANGLES ± 1°

DWN. BY	MSE 12-5-85
CHKD.	
ME	
EE	
PROJ. ENGR.	[illegible]
DFTG. SUPVR.	
MFG.	

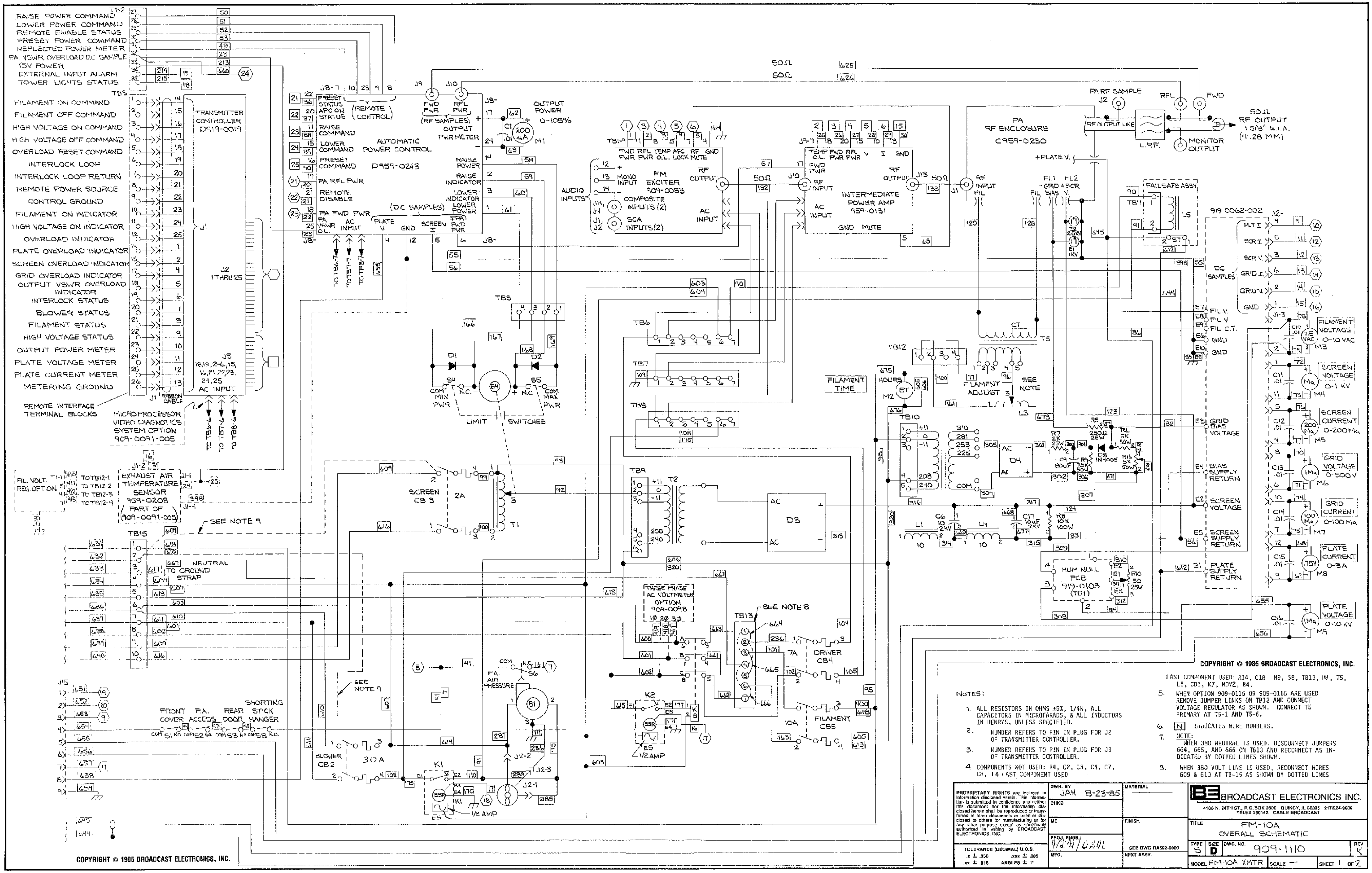
NEXT ASSY.
PRODUCT USED ON FM10A
FINISH

BE BROADCAST ELECTRONICS INC.
4100 N. 24TH ST. QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BCST ELECT QUI

TITLE: PCB ASSEMBLY – P.A. METERING BD.

SHEET 1 OF 1 | SCALE 2/1 | REV A

TYPE A | SIZE C | DWG. NO. 919-0062-002



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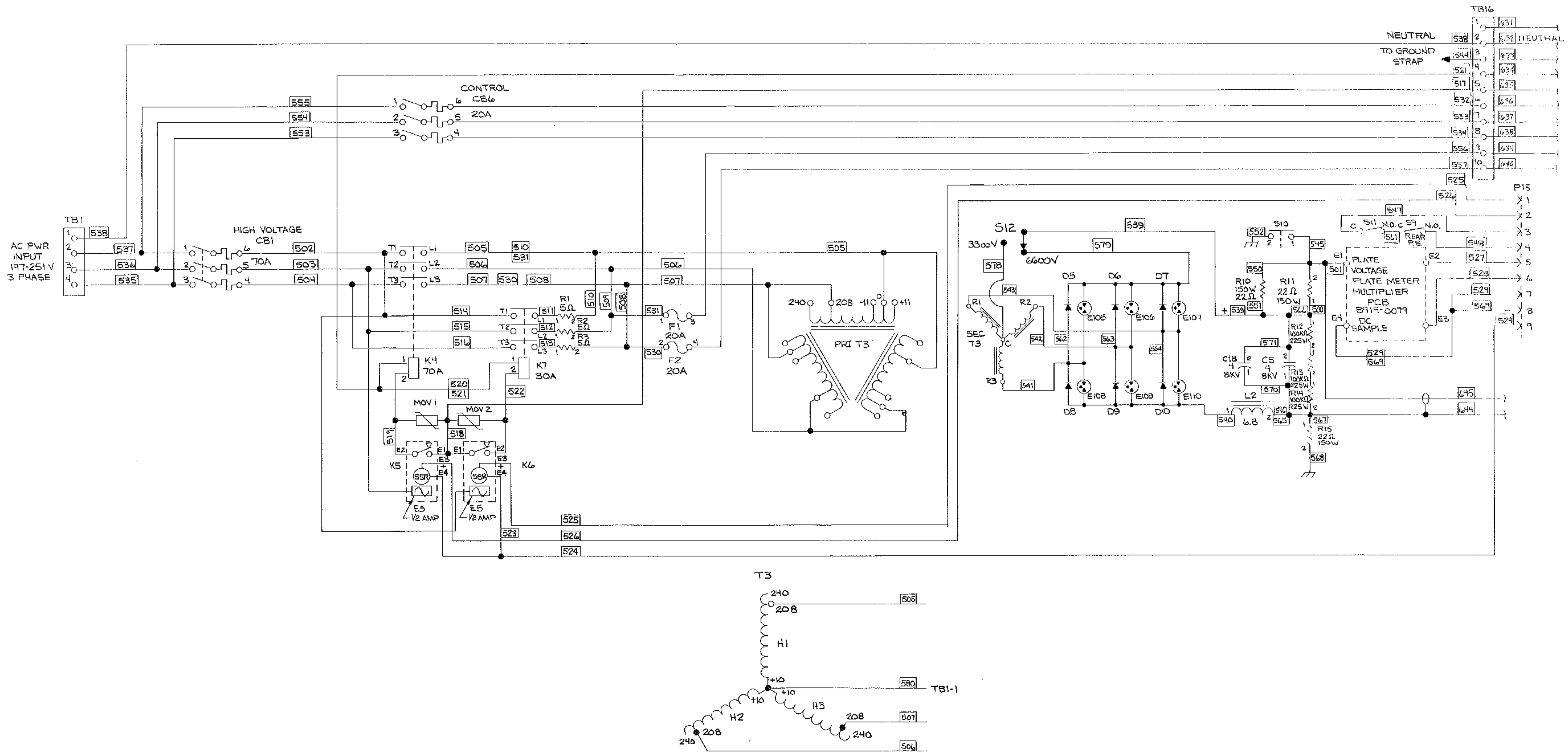
LAST COMPONENT USED: R14, C18 M9, S8, TB13, D8, T5, L5, CB5, K7, MOV2, B4.

NOTES:

1. ALL RESISTORS IN OHMS ±5%, 1/4W, ALL CAPACITORS IN MICROFARADS, & ALL INDUCTORS IN HENRYS, UNLESS SPECIFIED.
2. NUMBER REFERS TO PIN IN PLUG FOR J2 OF TRANSMITTER CONTROLLER.
3. NUMBER REFERS TO PIN IN PLUG FOR J3 OF TRANSMITTER CONTROLLER.
4. COMPONENTS NOT USED: R4, C2, C3, C4, C7, C8, L4 LAST COMPONENT USED
5. WHEN OPTION 909-0115 OR 909-0116 ARE USED REMOVE JUMPER LINKS ON TB12 AND CONNECT VOLTAGE REGULATOR AS SHOWN. CONNECT T5 PRIMARY AT T5-1 AND T5-6.
6. [N] INDICATES WIRE NUMBERS.
7. NOTE: WHEN 380 NEUTRAL IS USED, DISCONNECT JUMPERS 664, 665, AND 666 ON TB13 AND RECONNECT AS INDICATED BY DOTTED LINES SHOWN.
8. WHEN 380 VOLT LINE IS USED, RECONNECT WIRES 609 & 610 AT TB-15 AS SHOWN BY DOTTED LINES

TOLERANCE (DECIMAL) U.O.S. .x ± .030 .xxx ± .005 .xx ± .015 ANGLES ± 1°	DWN. BY JAH 8-23-85	MATERIAL —	BROADCAST ELECTRONICS INC. 4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600 TELEX 250142 CABLE BROADCAST
	CHKD	FINISH	TITLE FM-10A OVERALL SCHEMATIC
	ME	SEE DWG RA592-0000	TYPE S SIZE D DWG. NO. 909-1110 REV K
	PROJ. ENGR.	NEXT ASSY.	MODEL FM-10A XMTR SCALE — SHEET 1 OF 2
	MFG.		



380 WYE
NEUTRAL CONFIGURATION

STRAP +10 TAPS OF T3 AS FOLLOWS: H1 +10 TO H2 +10 WIRE #581
H2 +10 TO H3 +10 WIRE #582

TOLERANCE (DECIMAL) U.O.S.
.x ± .030 .xxx ± .005
.xx ± .010 ANGLES ± 1°

DWN. BY JAH 8-26-85
CHKD
ME
PROJ. ENGR. [illegible]
MFG.

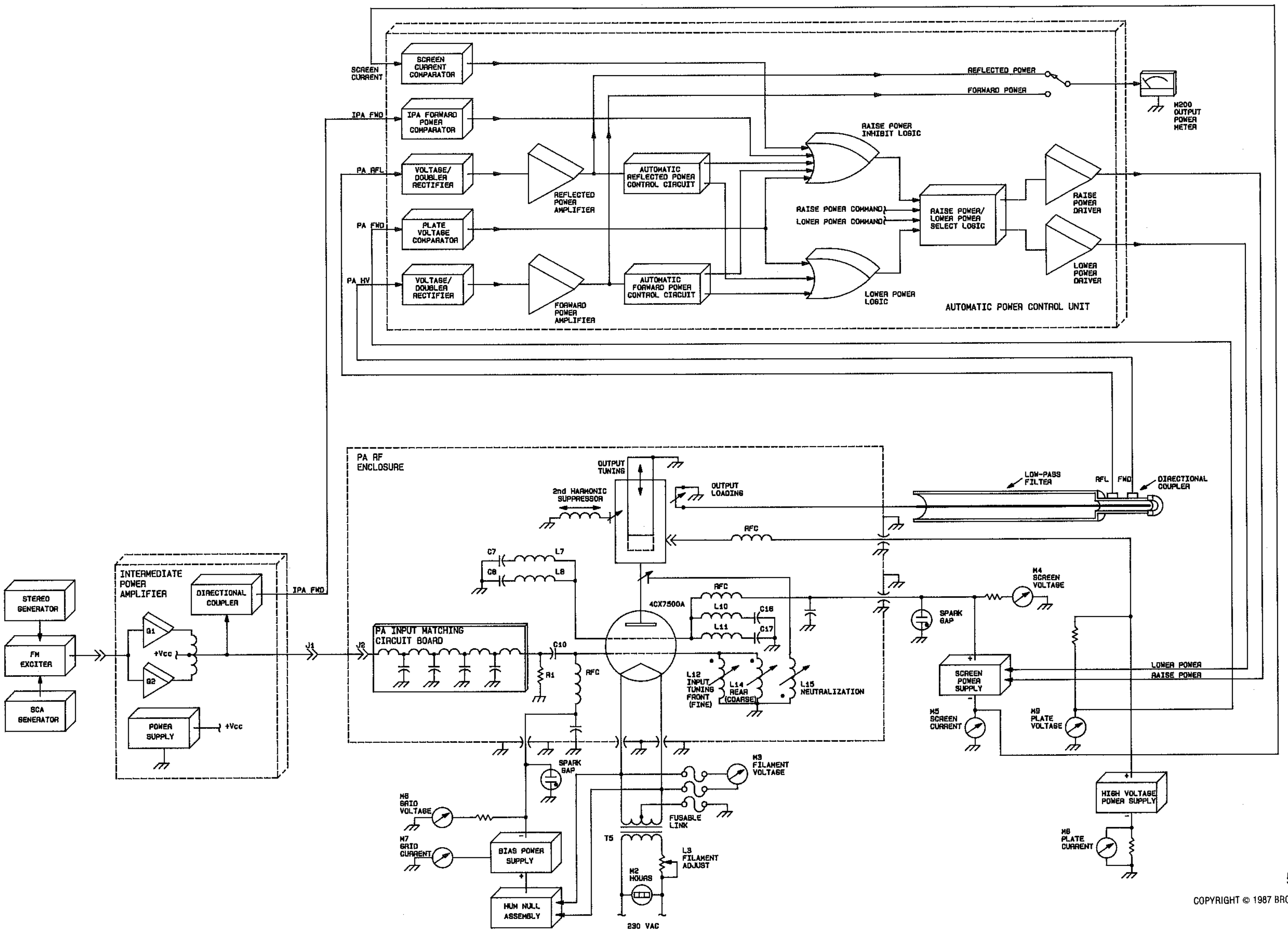
MATERIAL —
FINISH —
SEE DWG RA592-6000
NEXT ASSY. —

BROADCAST ELECTRONICS INC.
4100 N. 24TH ST., P.O. BOX 3606 QUINCY, IL 62305 217/224-9600
TELEX 250142 CABLE BROADCAST

TITLE FM-10A OVERALL SCHEMATIC

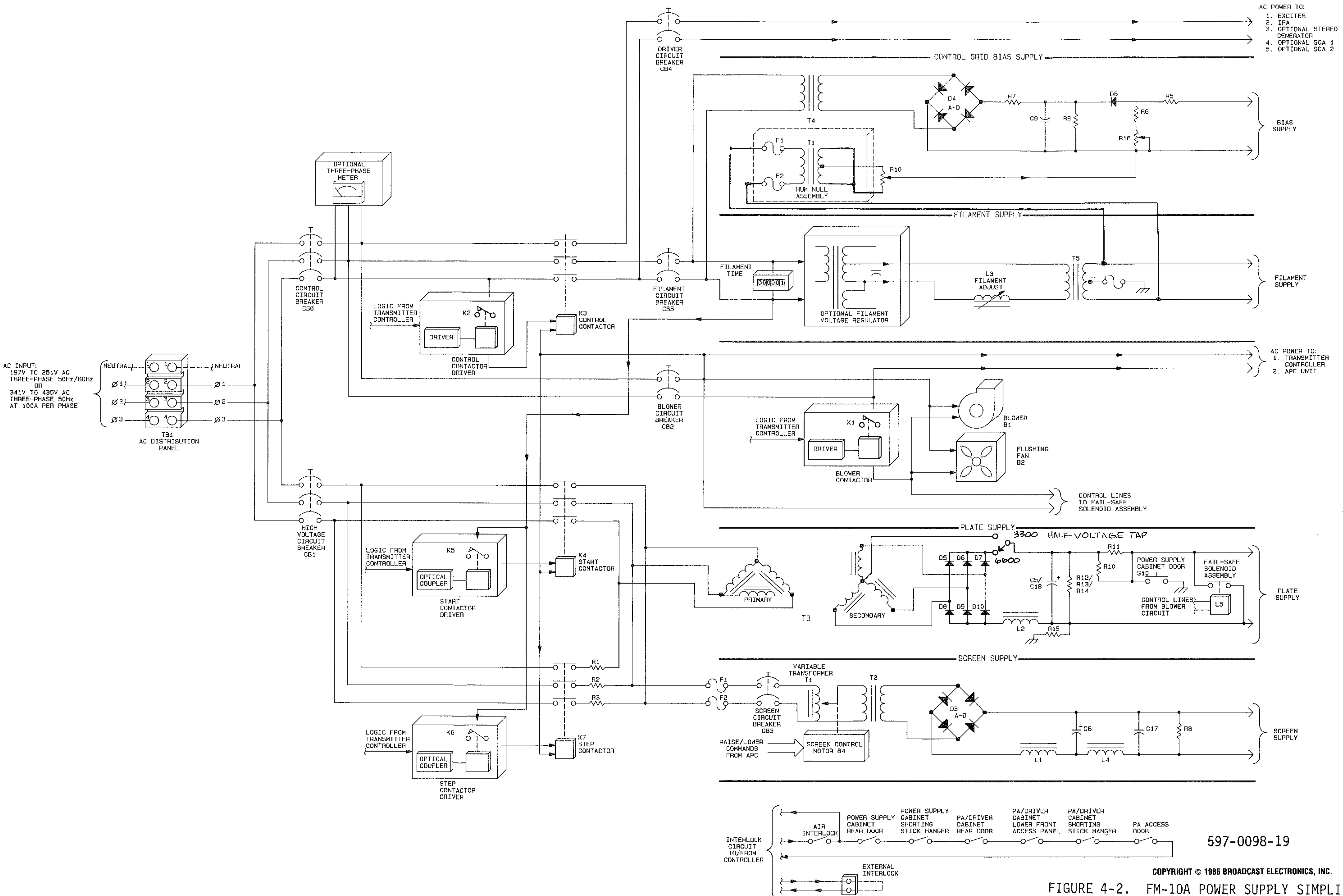
TYPE S SIZE D DWG. NO. 909-1110 REV K

MODEL FM10A XMTR SCALE — SHEET 2 OF 2



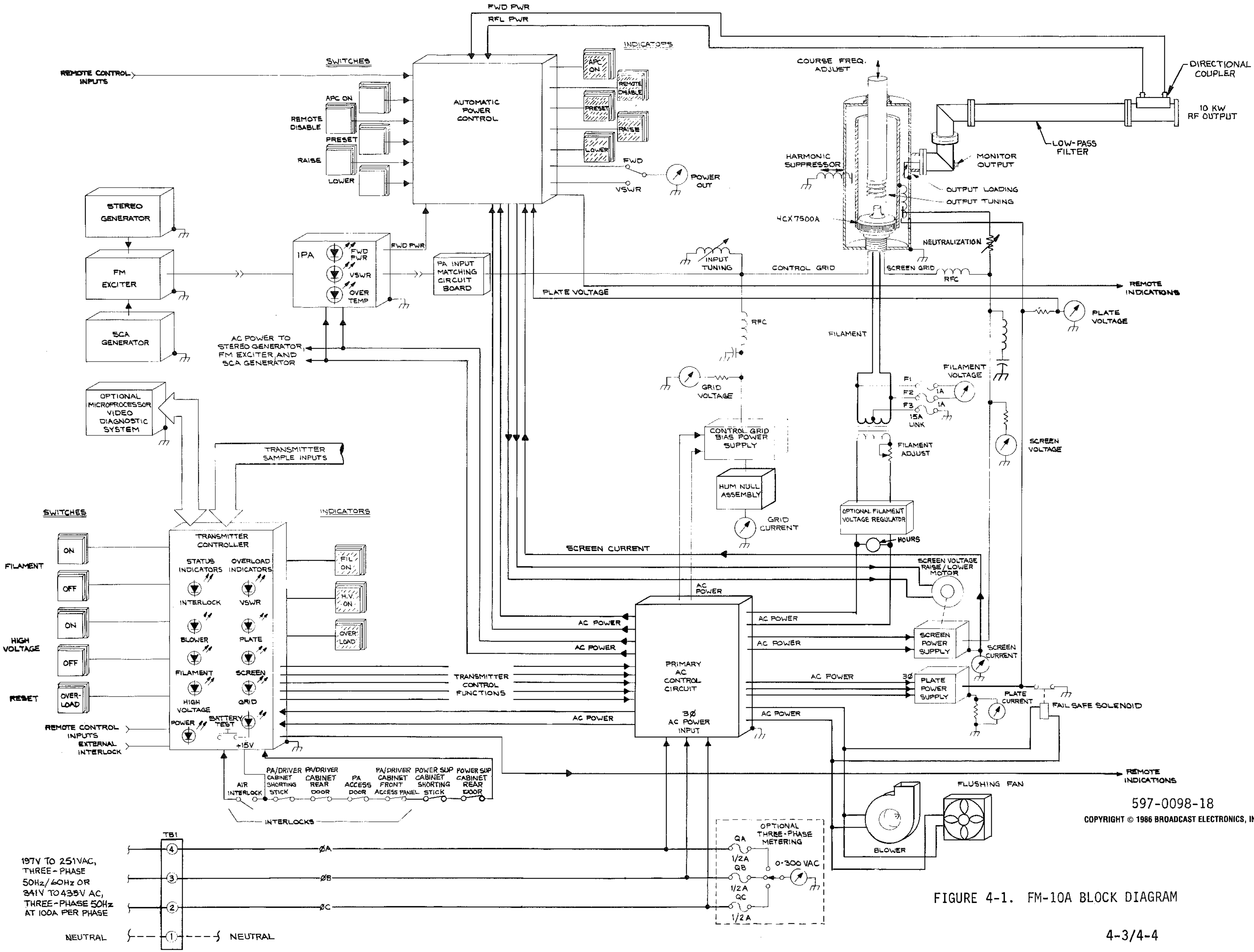
597-0098-20

FIGURE 4-3. FM-10A RF CIRCUIT SIMPLIFIED SCHEMATIC



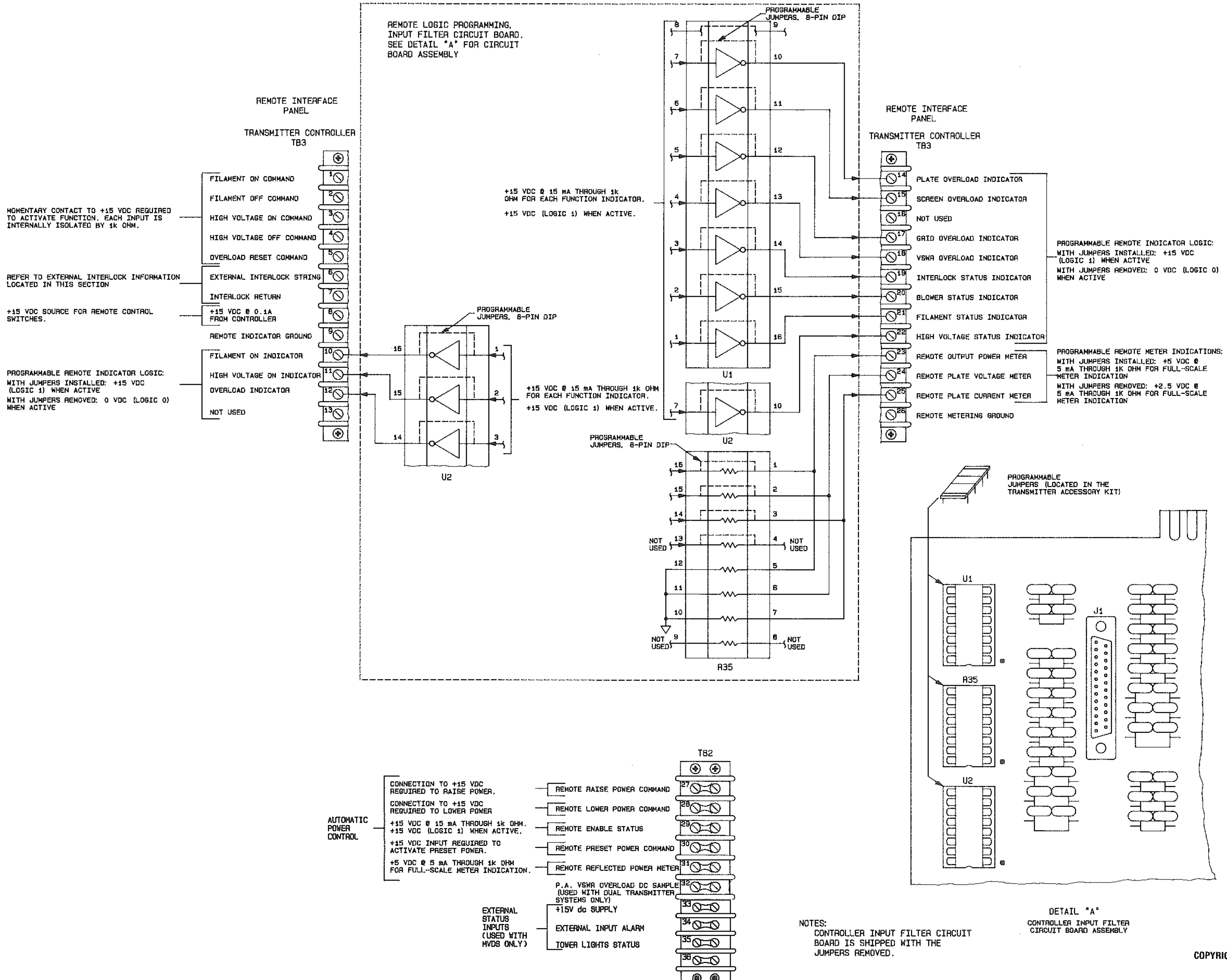
597-0098-19

FIGURE 4-2. FM-10A POWER SUPPLY SIMPLIFIED SCHEMATIC



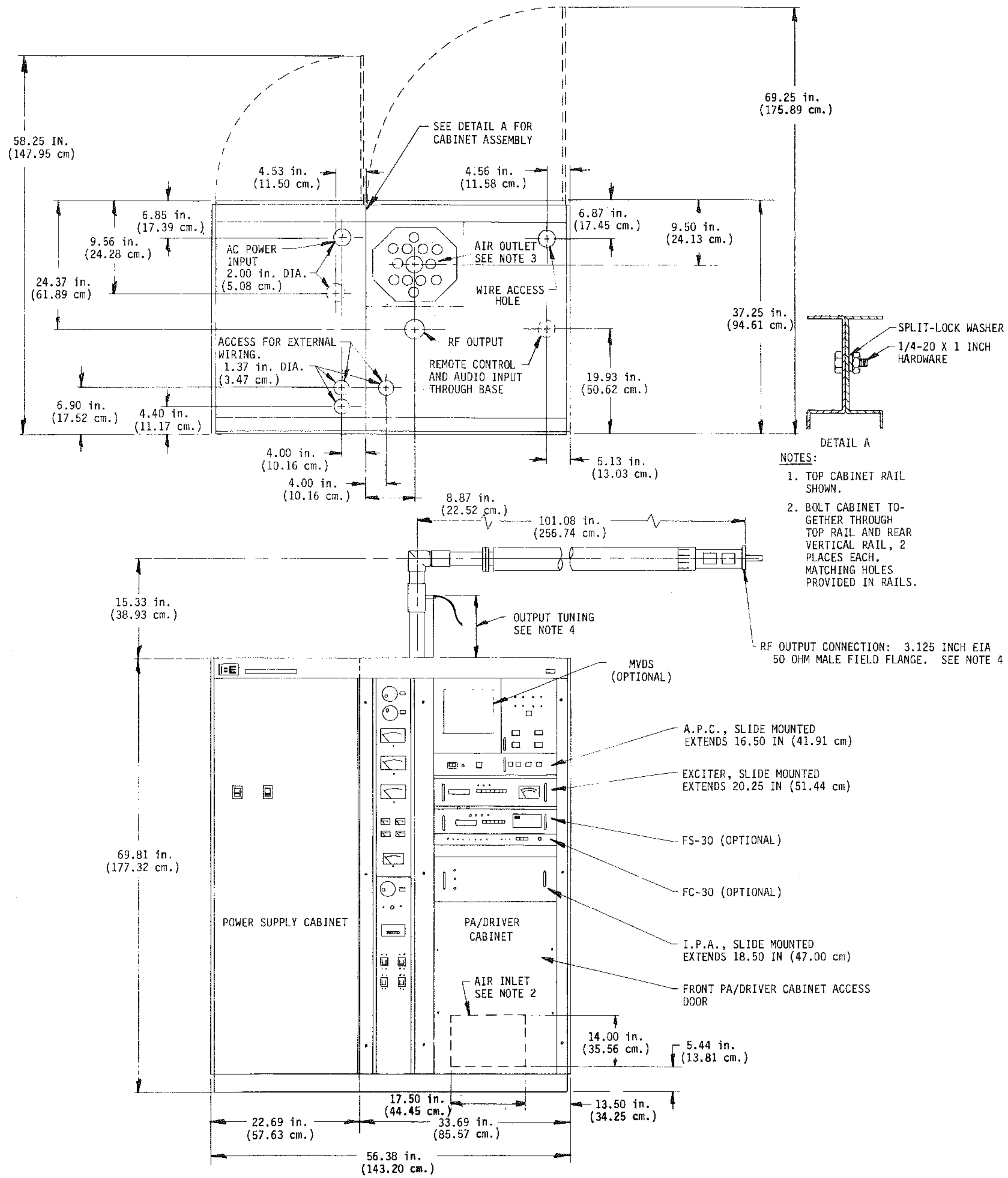
597-0098-18

FIGURE 4-1. FM-10A BLOCK DIAGRAM



597-0098-8

FIGURE 2-7. REMOTE LOGIC PROGRAMMING AND WIRING



NOTES:

1. POWER SUPPLY CABINET MAY BE LOCATED REMOTELY FROM PA/DRIVER CABINET IF DESIRED. 30 FEET (9.14 m) STANDARD.
2. AIR INLET, FILTER REQUIRED (BE P/N 407-0062).
   LOCATION: REAR OF PA/DRIVER CABINET
   DIMENSIONS:
   WIDTH: 17.5 INCHES (44.5 cm)
   HEIGHT: 14 INCHES (35.6 cm).
3. AIR OUTLET:
   LOCATION: TOP OF PA/DRIVER CABINET
   DESCRIPTION: 15 INCH (38.1 cm) SQUARE EXHAUST AREA CENTERED AROUND OUTPUT TUNING LINE.
4. RF OUTPUT ASSEMBLY:
   CONNECTION: 3.125 INCH EIA 50 OHM MALE FIELD FLANGE.
   LOW-PASS FILTER:
   DIMENSIONS:
   LENGTH (FLANGE-TO-FLANGE): 78.9 INCHES (200.3 cm).
   DIAMETER: 3.125 INCHES.
   MOUNTING: MECHANICAL SUPPORT REQUIRED EXTERNAL TO TRANSMITTER.

   TUNING LINE HEIGHT (DETERMINED BY TRANSMITTER FREQUENCY:
   MAXIMUM: 11 INCHES (27.94 cm), FREQUENCY: 108 MHz.
   MINIMUM: 1 INCH (2.54 cm), FREQUENCY: 87.5 MHz.
5. CUBAGE:
   PA/DRIVER CABINET: 53.0 CUBIC FEET (1.5 m^3),
   POWER SUPPLY CABINET: 36 CUBIC FEET (1.01 m^3)
6. WEIGHT:
   PA/DRIVER CABINET: 800 POUNDS (363 kg).
   POWER SUPPLY CABINET: 1000 POUNDS (453.6 kg).
7. FLOOR LOAD: 180 POUNDS PER SQUARE FOOT (MAX.).
8. COOLING AIR REQUIREMENTS: 800 CUBIC FEET PER MINUTE (22.6 m^3/min).
9. AC INPUT:
   196 TO 252V ac 50/60 Hz OR 341 TO 435V ac 50 Hz, THREE-PHASE CLOSED-DELTA OR WYE, 100 AMPERES MAXIMUM. FUSED DISCONNECT SWITCH RECOMMENDED. REFER TO THE NATIONAL ELECTRIC CODE OR LOCAL CODES FOR PROPER FUSE SIZES.
10. HEAT DISSIPATION (10 kW OUTPUT): 7 kW (25,000 Btu/H).
11. POWER CONSUMPTION: 17.2 kW FOR A 10 kW RF POWER OUTPUT, 0.9 POWER FACTOR.

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FIGURE 2-1. FM-10A INSTALLATION DIAGRAM